THE STATUS OF TEACHERS OF SECONDARY MATHEMATICS IN THE UNITED STATES

BY

BEN A. SUELTZ

PUBLISHED WITH THE APPROVAL OF
PROFESSOR W. D. REEVE, SPONSOR

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Faculty of Philosophy,
Columbia University

CORTLAND, NEW YORK

1934

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ACKNOWLEDGMENTS

The guidance and helpful criticism which the sponsor and the advisers of this study have given me are gratefully acknowledged. Appreciation is extended to Professor W. D. Reeve, of Teachers College, Columbia University, for his interest in the study and for his assistance in planning its organization; to Professor Helen M. Walker, of Teachers College, for her suggestions and her critical analysis of the presentation of material; to Professor E. S. Evenden, of Teachers College, for his service in procuring data of the National Survey of the Education of Teachers, of which he is the Associate Director, and for his helpful criticism of the manuscript; and to Professor E. R. Hedrick, of the University of California, and to Dr. B. W. Frazier, of the Office of Education in Washington, who, as chairman and member of the American Committee of the International Commission on the Teaching of Mathematics, gave invaluable aid in the securing of data.

Sincere thanks are due to Isabel Q. Sueltz for her kindly helpfulness and considerate indulgence during the preparation of this report.

I also wish to express my deep appreciation to Dr. David Eugene Smith, Professor Emeritus of Teachers College, who, through his writings and by his example, has inspired me throughout my professional career.

B. A. S.

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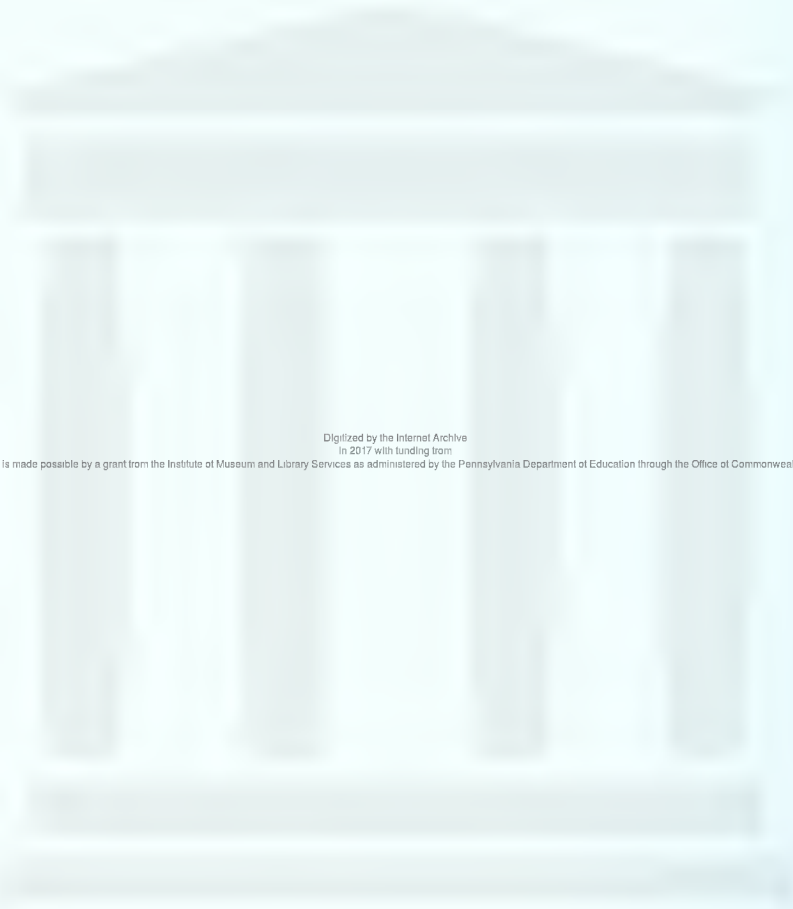

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THE STATUS OF TEACHERS OF SECONDARY MATHEMATICS IN THE UNITED STATES

CHAPTER I

INTRODUCTION

ORIGIN AND SETTING

The International Commission on the Teaching of Mathematics[1] was created at the Fourth International Congress of Mathematicians, held at Rome in April, 1908. Representatives from the various leading countries were selected to carry on an investigation of the teaching of the subject throughout the world and to prepare reports before the meeting of the Congress in 1912. The sponsorship of studies and surveys by the Commission in the various member countries has had a significant and far-reaching effect upon both organization and content of mathematics curricula in the United States as well as in Europe.

The American Committee of the International Commission was particularly active during the decade following its organization in 1908. Under the leadership of Professor David Eugene Smith of Teachers College, Columbia University, twelve separate committees and fifty subcommittees were organized with more than two hundred participating members. The scope of their activity is suggested by the titles of the various main committees. These were:

Committee I.	General elementary schools
Committee II.	Special elementary schools
Committee III.	Public general secondary schools
Committee IV.	Private general secondary schools
Committee V.	The training of elementary and secondary teachers
Committee VI.	Technical secondary schools
Committee VII.	Examinations
Committee VIII.	Influences tending to improve the work of the teacher

[1]This commission will henceforth be called International Commission. For a fuller description of its work see, Smith, D. E., W. F. Osgood, and J. W. A Young. 1912. Report of the American Commissioners of the International Commission on the Teaching of Mathematics. United States Bureau of Education Bulletin 1912, No. 14.

Committee IX. Technological schools of collegiate grade
Committee X. Undergraduate work in colleges of liberal arts
Committee XI. West Point and Annapolis
Committee XII. Graduate work in universities and institutions of like grade

These committees prepared reports which were published by the United States Bureau of Education (now Office of Education) at Washington, D. C. Publication by the federal Bureau of Education made it possible for these reports to be circulated widely at a low cost. The circulation of these reports coupled with a general interest in the work of the committees led to a renewed interest in mathematics and the teaching of it. The resulting agitation of teachers of mathematics which led to the preparation and publication of the study "The Reorganization of Mathematics in Secondary Education"[2] is in no small measure a germane development from the spirit of inquiry fostered by the International Commission. The report of this study was freely circulated and continues to be the most outstanding publication that has influenced the curriculum content and organization of mathematics in the secondary schools of the United States.

At the meeting of the International Commission held in Paris in April, 1914, it was decided to undertake an inquiry into the preparation, both academic and professional, of teachers of mathematics in the various participant-member countries. This investigation was planned as the final undertaking of the Commission whose authority should terminate at the next International Congress of Mathematicians. Immediately after the Paris meeting, preparations were made for a proposed conference in Munich in 1915. These preparations were never realized because of the intervention of the catastrophic world war. However, during July 1914, a central committee composed of Professors Klein of the University of Gottingen, Fehr of the University of Geneva, and Loria of the University of Genoa, met and formulated a questionnaire indicating the material about which the various national committees should report. A complete copy of this questionnaire is found in the appendix and is labeled Form A. The main headings are as follows:

[2]The Reorganization of Mathematics in Secondary Education. The Mathematical Association of America, 1923. Although this report is now out of print, a revision of Part I by J. W. Young has been published by Houghton Mifflin Co., Boston, Mass.

I. General preparation of candidates
II. Theoretical scientific teaching
III. Professional training
IV. Subsequent improvement
V. Legal provisions as to teachers
VI. Bibliography
VII. Additions

A brief inspection of the complete questionnaire will show that the central theme of the proposed study dealt with the various phases of educational preparation of teachers of mathematics for the secondary schools. A careful scrutiny of the contents will reveal that many of the items are particularly adapted to European educational systems and not ideally adapted to the various state systems in this country.

At the meeting of the Congress of Mathematicians held in Geneva in 1928, the activity of the International Commission on the Teaching of Mathematics was again revived. David Eugene Smith of New York was chosen president and Henri Fehr of Geneva continued as secretary. At this meeting it was decided that the work of the Commission, as planned before the war, should be renewed. The questionnaire mentioned previously was brought forth for reference in guiding the investigations of the individual national committees. Professor E. R. Hedrick of the University of California was appointed chairman of the American Committee, and the work of studying the education of teachers of secondary-school mathematics began. Concurrently, a large national survey[3] of the education of teachers in the United States was begun by the Office of Education under the active direction of Professor E. S. Evenden of Teachers College, Columbia University.

The study that is reported herein has been made in conjunction with the American Committee of the International Commission on the Teaching of Mathematics, and the National Survey of the Education of Teachers. This study will present various items of background, of education, and of experience of teachers of mathematics in the secondary schools. A more complete description of this study together with the different inquiry forms used is given in the second chapter of this report.

[3]The National Survey of the Education of Teachers. Reports of various phases of this survey are published by the Office of Education, Department of the Interior, Washington, D. C.

SECONDARY SCHOOLS IN THE UNITED STATES

In order that this report concerning the education and status of teachers of mathematics in the secondary schools may be intelligible to those unfamiliar with the general plan of education in the United States, a brief description of these schools is given.

While the secondary schools of this country are descended from the Latin schools of England, they have developed as a secondary link between a rather well-defined elementary school and college. Hence the college has unconsciously as well as consciously, exerted a great influence on all phases of secondary education, and particularly on the content of curricula. In the field of mathematics several desirable influences are cited: (1) mathematics has been given high public prestige (2) a fairly satisfactory level of content has been attained, due to the writing of textbooks by college-trained scholars. Some of the undesirable influences are: (1) mathematics has been kept formal, rigorous, and pure, with disciplinary emphasis on the subject, (2) any change in content has been almost impossible.

For many years the elementary schools, which precede the secondary schools, have existed as a state-maintained and publicly-supported unit of eight years, this unit receiving the pupils on the average at the age of six years and graduating them at the age of thirteen years. They are then admitted to the public secondary schools, which are generally called high schools. In the past, these high schools (secondary schools) have usually had a four-year course which aimed to prepare the pupils for college. This system operated fairly well until the later decades of the last century when the number of public secondary schools increased rapidly. "Within a period of thirty years the high-school enrollment has increased from a little over 10 per cent of the population of high-school age to more than 50 per cent of that population."[4]

The effects of the rapid growth of secondary schools and the accelerated growth of attendance in these schools have been very significant. While these schools existed in small numbers, their one major purpose was the preparation of pupils for college. These pupils represented a somewhat highly-selected level of intelligence. Due to the rather popular ideal of this democratic

[4]Articulation of High School and College. United States Office of Education, Bulletin 1932, No. 17, Monograph No. 10, page v.

country, that every child in the land is entitled to a high-school education at public expense, we have had to add many more secondary schools to accommodate the large numbers of pupils qualified for, and seeking admission. Consequently, with more than 50 per cent of the available population now attending these secondary schools, we have a lower level of intelligence in them than we had formerly, and we have been obliged to change the aim of secondary education from that of preparation for college to that of a general and less thorough and rigorous education. Some of the public high schools continue to give a college-preparatory course to all pupils, while others provide several courses ranging from vocational to classical in an endeavor to provide the best type of education for particular groups of pupils.

These changes in the social and intellectual constitution of the secondary-school population have forced the school to adopt new aims and methods of instruction, new curriculum materials, and new types of school organization. These changes appeared at the rise of the present century and have progressed steadily ever since. Nevertheless, it is only fair to state that the aims and organization of the secondary schools have not kept pace with the changes in the social and intellectual constitution of the school population. Table 1 shows the traditional elementary and sec-

TABLE 1

TRADITIONAL AND MODERN ORGANIZATION OF ELEMENTARY AND SECONDARY SCHOOLS

Traditional organization			Modern organization		
Type of school	Normal age of pupils	School years	Type of school	Normal age of pupils	School years
Elementary.....	6-13	1-8	Elementary	6-12	1-6
Secondary.....	14-18	9-12	Secondary		
			a. Junior high school	13-15	7-9
			b. Senior high school	16-18	10-12
			c. Junior college	19-20	13-14

ondary school organization and the newer or "modern organization" as it is called in this country.

That the modern organization of secondary schools is growing, is evidenced by the rise of the junior high school. In 1909 the first two junior high schools were established. In 1922 there were 387, and by 1928 this number had swelled to 1,403 separately organized junior high schools. In addition to these, there were 1088 combined junior-senior high school organizations in 1922, and 2429 in 1928.[5]

The main purpose of the newer type of organization is to lessen the sharp break that formerly existed between elementary and secondary education, and to make it easier to provide materials and methods of instruction that better fit the social and economic, and the emotional and intellectual qualities of the particular age levels in each unit of organization. The junior high school with its adolescent pupils encourages exploration as well as the traditional secondary-school aim of mastery of materials. The senior high school exists as a unit in which the pupil may pursue further and master the materials with which he has already become acquainted in the junior high school. It is evident that the newer type of organization is growing, and that it is destined to have a significant effect upon the education of a people definitely committed to the principle that all children, regardless of economic standing, shall have the right to a free public education, which shall include at least the work of the junior high school and probably the work of the senior high school.

From Table 2, which summarizes the curriculum content of the newer and older types of school organization, it is apparent that a significant difference in mathematics curricula exists. Although there are other arrangements in actual operation because each state controls its own schools, the arrangement in the table is a typical one.

In general, secondary education in the United States is provided in the public high schools. However, a small minority of privately maintained secondary schools exists for such specific purposes as the preparation of pupils for college or for the education of pupils who are members of some particular religious denomination. These private schools employ approximately 10

[5]United States Dept. of Interior, Office of Education, Bulletin No. 35, 1929, p. 3.

TABLE 2

CURRICULUM CONTENT IN MATHEMATICS OF TRADITIONAL AND MODERN ELEMENTARY AND SECONDARY SCHOOL ORGANIZATIONS

Type of school	School years	Curriculum content
A. TRADITIONAL		
Elementary	1-8	* elementary arithmetic including mensurational geometry
Secondary (high school)	9	* elementary algebra
	10	* plane geometry
	11	intermediate algebra ½ year higher algebra ½ year
	12	solid geometry ½ year
B. MODERN		
Elementary	1-6	* elementary arithmetic
Secondary		
a. Junior high school**	7-9	* general mathematics including: intuitive geometry, social and business arithmetic, numerical trigonometry, elementary algebra, and some demonstrative geometry
b. Senior high school**	10	**** plane geometry
	11	algebra and trigonometry
	12	solid geometry and calculus
c. Junior college ***	13-14	algebra, analytic geometry, trigonometry and calculus

*These courses are usually required of all pupils.

** In a minority of schools the term junior high school includes grades 7-8 only.

*** Due to the novelty of this unit of school organization, it is not well-articulated in organization and curriculum.

**** In some schools general mathematics is offered in grades 10-12.

per cent as many teachers as do the public high schools.[6] The curricula of the two types of school are noticeably similar.

Attention should be called to the intermixture of races in this country. While descendants of European races are the dominant majority and exhibit the controlling factors in education, a group of negroes comprise less than 5 per cent of the total secondary school population.[7] Most of these negroes are found in one-third of the states, chiefly southern, and are often educated in segregated schools provided for this purpose. The other racial elements are insignificant minorities that are most often educated in the regular elementary and secondary schools where the white race is the prevailing element.

A difference between secondary education in the United States and in Europe is found in the sex of the teachers. While in Europe the large majority of secondary school teachers are men, in this country the majority of them are women. Although this may not weaken the organization of, and instruction in our secondary schools, it is significant because it tends to undermine the more complete professionalization of the teaching staff. Very often women as well as men teachers continue in the work for only a few years and then seek careers in other fields.

[6]Biennial Survey of Education in the United States 1928-1930. Office of Education, Bulletin 1931, No. 20, Chap. I, p. 8.

[7]*op. cit.*, Chap. VI, p. 13.

CHAPTER II

PLAN OF THE STUDY

MAIN CONSIDERATIONS OF THE STUDY

This study deals with the teachers of mathematics in the public secondary schools of the United States. While the elementary schools are now the educating agencies of the whole citizenry, the secondary schools are rapidly becoming so. In short, the public high school has become an expected institution in every community. The importance of this study depends not only upon the prevalence with which mathematics is taught in these secondary schools but also, and more fundamentally, upon the unique role that mathematics has occupied and continues to occupy in the development of our civilization.

Briefly stated, this study seeks to determine certain factors or elements of status of the present group of teachers of secondary school mathematics; to study these elements critically, and to formulate some guiding principles for the future. Stated more in detail the study involves a consideration of the following:

1. Certain social and economic characteristics
2. Certain characteristics of educational training
3. Certain characteristics of the teaching job
4. The experience of teachers
5. The helpfulness of certain factors influencing teaching success
6. Reasons why present teachers have become teachers of mathematics
7. Reasons why present teachers did not study more academic mathematics
8. Reasons for teaching certain courses in mathematics
9. Professional magazines read by present teachers of mathematics
10. State legislation relating to certification
11. Formulation of some theses for education of teachers of mathematics

In addition to the direct inquiry-studies suggested immediately above, a number of studies of the relationships of different factors will be presented. Among the possible studies of this type only the more significant will be presented in this report. They involve the relationship between:

1. The highest level of training and the size of community in which the teacher is working
2. The highest level of training and the number of years of experience
3. The highest level of training and the age of the teacher
4. The amount of credit in the major teaching field and the source of the bachelor's degree
5. The amount of credit in the major teaching field and the number of years of experience
6. The mathematical background of those who teach mathematics mainly and those who teach mathematics as a minor interest
7. The mathematical background of those who teach only algebra, and of those who teach only geometry
8. The amount of college mathematics studied and the teacher's statement of the helpfulness of this to her as a teacher of mathematics
9. The number of years of teaching experience and the teacher's statement of the helpfulness of courses in mathematics
10. The amount of credit earned in educational theory and the teacher's statement of the helpfulness of this to her as a teacher of mathematics
11. The amount of credit earned in educational theory and the experience-development level of the teacher
12. The amount of credit earned in educational theory and the teacher's reasons for not having studied more academic mathematics
13. The certification standards now existing in the several states and the status of the present teaching population

RELATED STUDIES AND RESEARCHES

Previous studies dealing with the status of secondary teachers in the United States have not included the entire group of teachers described herein. Studies of teacher training and teaching load have been made in individual states and in groups of states.

Because the teaching population is continually changing and because the isolated studies that pertain to mathematics teachers have been conducted at different times, it seems advisable to omit statements of their findings in this report. However, it will be desirable to use certain of them to check and to corroborate the findings in the present study. Those previous studies that are considered of greater importance will be found listed in the bibliography.

For an extended list of research studies and other reports that relate to the education and status of teachers of secondary school mathematics, the reader is referred to such catalogues as the Bibliography of Research Studies in Education[1] and The Education Index.[2] The Office of Education prepares annually a compilation of research studies in education comprising masters' and doctors' theses and other investigations. The Education Index presents a cumulative author and subject index to a selected list of educational periodicals.

During the past twenty years the various state departments of education have been actively at work studying the education of teachers within their jurisdiction. The standards for teachers have been raised by adjusting certification requirements as facilities were made available for more and better education. Reports showing the activities of some of the states in studying and in regulating teacher-preparation are available. The most recent comprehensive compilation of state regulations is the study by Bachman.[3] A study that deals entirely with teachers of secondary mathematics was made for the American Commission in 1917 by Professor Archibald[4] of Brown University.

In addition to the influence within states of the departments of education, several accrediting bodies have had sectional influences upon the status of teachers. Two of these bodies are: 1. The Association of Colleges and Secondary Schools of the Southern States (established in 1895) and 2. The North Central Association (established in 1894). The prestige given a school through membership in one of these organizations has been suffi-

[1]Bibliography of Research Studies in Education. United States Dept. of the Interior, Office of Education. Washington, D. C.

[2]The Education Index. The H. W. Wilson Company, New York City.

[3]Bachman, Frank P. 1930. Training and Certification of High School Teachers. Field Studies No. 2. George Peabody College for Teachers, Nashville, Tenn.

[4]Archibald, Raymond C. 1918. The Training of Teachers of Mathematics. Dept. of the Interior, Bureau of Education, Bulletin 1917, No. 27. Government Printing Office, Washington, D.C.

cient stimulus to many school officials to raise the standards within their schools in order to qualify for membership. Similar mutual organizations have been formed in other sections of the country and while their scope has been more limited than that of the North Central Association, nevertheless they have been definite conditioning factors in secondary education. The reports and proceedings of these mutual accrediting bodies are an additional source of information.

The success of this study depends primarily upon the reliability of the information upon which it is based, and secondarily upon the effectiveness of the analysis and presentation of the crucial elements and generalizations that may be derived. Inasmuch as the information sought had not been previously collected by any one or several agencies and since the teachers of secondary mathematics were themselves the original sources, the direct inquiry form was selected as the better method of gathering data. To insure reliability and representativeness, several precautions were taken. These precautions are apparent from the descriptions of the inquiry forms and the manner in which they were used.

Teachers of mathematics were asked to participate in two inquiries. The first of these was conducted by the National Survey of the Education of Teachers, sponsored by the United States Office of Education. In this survey replies were received from approximately 465,000 teachers in the public elementary and secondary schools. This number represents slightly more than 50 per cent of the entire teaching population in the country as a whole. The question forms were carefully devised by leading educators in cooperation with the Office of Education and were distributed through school officers in each state. Because of the method of distribution, the returns do not represent the same ratio for each state as for the country as a whole. However, they are probably adequate for both the country and the individual state. The inquiry forms were dated January 12, 1931, and hence the information collected represents teachers in active service during the last half of the school year 1930-1931.[5]

The complete inquiry form used in the National Survey of the Education of Teachers may be found in the appendix and is labeled Form B. Because this survey included both elementary

[5]For a more complete description of this survey see the statement prepared by the Dept. of the Interior, in the Elementary School Journal, Vol. 31, pp. 405-7, Febr. 1931.

and secondary teachers and because the form consists of a single sheet the items are more inclusive than detailed. The specific mathematical information about teachers of mathematics is meager, but there is much interesting and valuable descriptive information concerning these teachers and their employment. Of the 465,000 returns, approximately 12,000 are from teachers of mathematics in the public senior high schools. Senior high school is defined here as grades 10-12, where a junior high school is maintained, or grades 9-12 where no junior high school is maintained. Furthermore, these 12,000 teachers teach mathematics primarily; other subjects or fields in which they teach are of minor interest. Through the cooperation of Professor E. S. Evenden, associate director in charge of the survey, and the Office of Education, a sample of 4000 returns was provided for this study. This sample was selected by taking every third card from the entire group of 12,000. The data thus secured is presented in Chapter III of this report.

Although the inquiry of the National Survey of the Education of Teachers contained much helpful information, individual members of the American Committee felt that more detailed information about the education and teaching positions of mathematics teachers should be obtained. In cooperation with Professor W. D. Reeve a list of desired items of information was prepared. This list was checked with the questionnaire (appendix, Form A) prepared by Messrs. Klein, Loria, and Fehr, and also with the National Survey form (appendix, Form B). A new tentative inquiry form was then devised which requested items of information not obtained previously. Certain items of this tentative form were then used experimentally with a group of fifty teachers of mathematics.

After slight revisions and suggestions were incorporated, the inquiry form was presented to Professors Reeve and Hedrick of the American Committee in session with Dr. David Eugene Smith, president of the International Commission.[6] Minor changes in the form were suggested by members of the group. It was decided that this revised inquiry form should be sent as an auxiliary inquiry conducted by the American Committee to a representa-

[6]At this meeting due notice was taken of the untimely death of Professor J. W. Young of Dartmouth University, Hanover, New Hampshire. Professor Young's place on the American Committee was filled by the appointment of Mr. Ben A. Sueltz of the State Normal School, Cortland, New York. Mr. Sueltz had been working with the Committee previously.

tive sample of schools throughout the country. Finally, this inquiry form was sponsored and sent jointly by the American Committee and the National Survey of the Education of Teachers. The complete form is given in the appendix and is labeled Form C.

Representativeness, as defined by the committee in session, should include not only every state but also every main size of community within each state. Further, any known disturbing factor, such as the presence of teacher-training agencies in many of the large cities, should be fairly but not unduly represented. In order to secure representativeness in each state, communities ranging in size from the largest city to the small towns and villages were selected. Because the states differ so in population-concentration, it is not possible to define such terms as "medium" and "large" in units of population. Because the number of small communities is so much greater than the number of large cities only one senior high school and one junior high school were selected in the largest city while several small-town or village communities were included. There is no proof that any of the selected communities are typical of their population class, neither is there reason to believe that any is specially atypical. There is evidence, however, that the entire group of teachers finally reached is fairly representative. This evidence consists in a relative closeness of agreement of certain items of data in this survey with similar items found in the National Survey of the Education of Teachers. This comparison will be presented later.

Letters were sent to principals of 304 schools in cities asking if these schools would participate in the study and requesting them to indicate the number of inquiry forms they required. Of these, 189 responded. The inquiry forms were then sent to these schools. When insufficient responses to the original letters were received from some states, other schools were selected. The inquiry forms, together with an explanatory letter were sent directly to the principals of schools in smaller cities, towns and villages. From a total of 251 such letters, 121 replies were received in time for tabulation. This latter method proved quite satisfactory and no doubt could have been used to advantage in the larger cities. It is apparent that the public schools are more frequently accepting legitimate inquiry, and expecting to give information, relative to their work, to official bodies. Despite the fact that these data

were gathered during the busy school months of April and May, official sponsorship unquestionably aided in securing so gratifying a response, totalling 1032 teachers.

The information collected by this auxiliary inquiry form (Form C, appendix) relates to teachers of mathematics in the public secondary schools in service during the second half of the school year 1931-1932. Hence this information pertains to a teaching population in service one year later than that represented in the National Survey of the Education of Teachers. The complete description of the data collected by the survey of the American Committee appears in Chapter IV.

These two surveys, carried out in successive years and with different samples of teachers, both assembled data concerning the academic degrees held by teachers of mathematics and the number of semester hours of credit in educational theory[7] earned by them. This comparison of data is presented in Tables 3 and 4, respectively. The higher percentage of master's degrees shown in the data collected by the American Committee is in part due to the inclusion of degrees earned during the school year 1931-32. Both surveys show considerable general similarity in respect to the amount of credit earned in educational theory. Disagreements in the two bodies of data are partly accounted for by the fact that teachers often have only a relative estimate regarding the amount of credit earned in a particular field. It is also true that there is some confusion in defining such types of educational training as practice-teaching[8] and such courses as the *teaching of mathematics*. In the American Committee's survey, these were separated from educational theory, while in the National Survey only practice-teaching was separated. With these apparent weaknesses in a direct comparison, it is felt that the agreement between the two studies is relatively close.

The National Survey of the Education of Teachers gathered information from more than half the total number of public school teachers and since the sample of mathematics teachers selected therefrom exhibits such a relatively close agreement with that of the American Committee's data, there is reason to believe that both surveys are rather accurate and representative. Further-

[7]Educational theory includes such courses as psychology, the philosophy of education, methods of teaching, etc.

[8]Practice-teaching usually includes actual participation in the organization and presentation of materials of instruction for pupils in secondary schools.

more, the returns of the inquiry forms of the American Committee give evidence of carefulness on the part of those supplying the information. Also the methods of distribution of both survey forms through school officials and their governmental sponsorship tend to make the information collected more reliable than similar information gathered by a private agency or an individual.

TABLE 3

DEGREES HELD BY TEACHERS OF SECONDARY MATHEMATICS*

Source of data	Per cent holding			
	No degree	Bachelor's degree	Master's degree	Doctor's degree
National Survey (N — 4000).....	7	93	9	0
American Committee (N — 1032).....	7	93	14	0

TABLE 4

SEMESTER HOURS OF CREDIT IN EDUCATIONAL THEORY EARNED BY TEACHERS OF SECONDARY MATHEMATICS*

Source of data	Per cent with given number of semester hours				
	0	1-12	13-24	25-40	Over 40
National Survey (N — 4000).....	5	9	45	30	11
American Committee (N — 1032).....	4	19	41	26	10

*The data are here presented in terms of the nearest whole per cent.

As regards reliability of information, the care exhibited in making responses is perhaps the greatest significant factor and also the one element hardest to demonstrate objectively.

The regulation of teachers' certificates and licenses is vested in a department of education maintained in each state. Because these regulations are being amended constantly, no previous study, however complete, can be relied upon to give this information currently. In order to overcome this objection to previous studies and because it was thought advisable to include a brief study of current practices in certification[9] as it pertains particularly to teachers of secondary mathematics, this information was assembled during December, 1932, by means of direct inquiry. This was done by sending a letter and an enclosed sheet of questions asking for specific information, to the officer of certification in each state. The letter requested that the customary printed regulations, governing the certification of teachers of mathematics in the secondary schools of the state, be sent, or if such document were not available or revised to date, the information might be inserted directly on the enclosed sheet. A copy of this sheet is labeled Form D, in the appendix. The response to this inquiry was both generous and rapid. In Chapter V, a summary of this material will be presented together with comparisons to data pertaining to the actual teaching population.

In order that some representative programs of institutions engaged in the preparation of secondary teachers might be included, four schools were visited and ten others were reached through correspondence. An inspection of two forms in the appendix, Forms E and E[1], shows that not only the actual program of studies pursued by students but also certain elements of school organization form the basis of this inquiry. Inasmuch as this information is used as illustrative material rather than as an absolute index of current practice, no further description of it will be given here.

This study is concluded with a section which presents some main guiding principles that should be observed in the education of prospective teachers of secondary mathematics. As basic material for these principles, the data of the study, the nature of secondary education including the nature of the pupils involved,

[9]Certification will henceforth be used to include licensing or otherwise issuing legal rights to teach in the public schools.

the trends in school practice, the facilities for the education of teachers, and a philosophy of education as it relates particularly to mathematics have been used. Specifically, the contributions of the study of mathematics to the development of a personality that is able to understand the complex problems of our economic industrial age form the basis for principles of teacher-preparation. The practical worth of the study must therefore rest upon the assumption that mathematics as a branch of human learning, is a fundamental mode of dealing with relationships to which may be ascribed magnitude, number, or order.

CHAPTER III

GENERAL CHARACTERISTICS OF TEACHERS OF SECONDARY MATHEMATICS

INTRODUCTION

The material in this chapter is based upon an analysis of the data collected by the National Survey of the Education of Teachers. The data consists of a sample of 4000 teachers of mathematics who teach mathematics mainly, in the public secondary schools of the United States. Furthermore, these 4000 persons all teach in senior high schools where senior high school is defined as a school having grades 9 to 12 inclusive, or if a separate junior high school is maintained the senior high school includes only grades 10, 11 and 12. These teachers were selected from a larger group of 12,000 teachers by taking every third one. This was done in the Office of Education at Washington. Hollerith cards containing the data for these 4000 teachers were then prepared and forwarded to the writer for use in this study. The sample represents forty-six of the forty-eight states and the District of Columbia. The range of cases according to states is from 3, in such sparsely populated states as Nevada and New Mexico, to 513 and 543 in the densely populated states of Pennsylvania and New York, respectively. The mean number of teachers per state is 81.5. The method of selection of the sample together with its distribution suggests that it is rather representative of the country as a whole. Internal evidence and comparison with similar data collected by the survey of the American Committee also give evidence of the fairness of the sample.

In all tables where per cents are given, these are in terms of the nearest whole per cent which is no doubt as correct as the limits of accuracy of the data from which they are derived.

SIZE OF COMMUNITY AND NUMBER OF TEACHERS PER SCHOOL

As measures of the concentration of the school and teaching populations in the United States, communities in which schools are located have been separated into five groups. These groups

range in size from the open country to large cities of more than 100,000 population. The schools in these communities have been divided into eight groups, depending upon the number of teachers within the schools.

Table 5 shows the distribution of communities from which the 4000 teachers have been chosen, with the per cents found in each of the five groups. That 40 per cent of the teachers are working

TABLE 5

NUMBER AND PER CENT OF TEACHERS EMPLOYED IN SECONDARY SCHOOLS IN COMMUNITIES OF VARYING POPULATION

Type of community	Number of teachers	Per cent of total
Open Country	245	6
Villages less than 2500	1367	34
City, 2500 to 9999	691	17
City, 10,000 to 99,999	840	21
City, 100,000 and over	829	21
Unaccounted	28	1
Total in this study	4000	100

TABLE 6

NUMBER AND PER CENT OF TEACHERS CLASSIFIED ACCORDING TO NUMBER OF TEACHERS PER BUILDING

Number of teachers in building	Number of teachers	Per cent of total
1	117	3
2	101	3
3 or 4	419	11
5 to 9	892	22
10 to 24	969	24
25 to 99	1148	29
100 to 499	298	7
500 or over	4	0
Unaccounted	52	1
Total in this study	4000	100

in schools located in communities having less than 2500 population, is a significant fact which should be kept in mind when recommendations concerning teacher-preparation are formulated. These per cents are in fair agreement with similar, but not comparable, data assembled in the Biennial Survey of Education in the United States (1928-1930) where 47 per cent of all teachers in regular high schools for white pupils, and for white and negro pupils, are located in communities of less than 2500 population.[1] In this biennial survey "regular high school" includes only high schools where no reorganization to include a junior high school has taken place. Approximately three-fourths of the high schools are of the regular non-reorganized type, in which pupils are offered high school work after having completed an elementary course of 7, 8, or 9 years in length.[2] It should be remembered that the sample of 4000 teachers includes not only teachers in "regular high schools" but also those teachers in senior high schools of the reorganized type. Forty per cent of our teachers are located in urban communities having a population of 10,000 or more.

The distribution of the number of teachers per school building is shown in Table 6. This is an indication of the size of high schools in operation according to the number of teachers employed, including all teachers. While the number of teachers per building is fairly well distributed, it is worth noting that 36 per cent are found in schools employing 25 or more teachers, and that several schools employ more than 500 teachers.

From Tables 5 and 6, it is estimated that the central tendency is a school having from 15 to 20 teachers, located in a community having a population slightly less than 10,000.

SOCIAL AND ECONOMIC CHARACTERISTICS OF MATHEMATICS TEACHERS

This sample of 4000 teachers of mathematics in the public high schools of the United States has been restricted to members of the white race. Although about 5 per cent of all secondary teachers belong to the Negro, American Indian or other races, they constitute such a small percentage that their inclusion would not materially affect the general status of the teaching population in respect to the elements herein reported. Teachers who are

[1]Adapted from the Biennial Survey of Education in the United States 1928-1930. United States Dept. of the Interior, Office of Education, Bulletin 1931. No. 20. Vol. II, p. 88.

[2]Ibid. p. 2

officially classed as belonging to races other than the white race, often have some white ancestry. They are usually subject to the same regulations of certification as the white teachers, and are educated in the same or similar institutions of learning.

The distribution of this sample of teachers according to sex and marital status is set forth in Table 7. It is evident that unmarried women and married men are the two dominant types, with women comprising 55 per cent of the group teaching secondary mathematics, and men, the remaining 45 per cent. While 48 per cent of the group are single women, only 7 per cent are or

TABLE 7

SEX AND MARITAL STATUS OF MATHEMATICS TEACHERS

Marital status	Men		Women	
	Number	Per cent	Number	Per cent
Single	696	17	1913	48
Married	1059	26	253	6
Divorced	8	0	11	0
Widowed	21	1	37	1
Unaccounted			2	
Total	1784	45	2216	55

have been married women as compared with married men who constitute 27 per cent of the total group. This small percentage of married women does not mean that women teachers of mathematics do not marry, but rather, it suggests that the usual procedure is for women to leave the teaching profession when they marry. This is one factor that operates to produce a high teacher turn-over and hence to account for the large percentage of teachers who have had five or less years of experience, as is shown in Table 9. Also, there is a feeling in the United States that women teachers who marry should give up their positions to others who are unmarried. This is particularly apparent in times of general business depression when the people who are legally certified to teach exceed the number of available positions. Many local boards, in whose hands rests the power to employ and discharge

teachers, dismiss those who marry. Yet those same board members continue to employ married women in their own private business concerns so long as marriage does not interfere with success and efficiency. This attitude toward marriage among women teachers undermines the stability and professionalization of teaching.

Teachers in the United States are relatively young as compared with teachers in similar positions in Europe. Table 8 shows that

TABLE 8

AGE OF MATHEMATICS TEACHERS IN FIVE-YEAR GROUPS

Age in years	Number of teachers	Per cent of total
20-24	806	20
25-29	1224	31
30-34	729	18
35-39	447	11
40-44	285	7
45-49	225	6
50-54	143	4
55-59	79	2
60-64	45	1
65 and over	13	0
Unaccounted	4	0
Total	4000	100

more than 50 per cent of these teachers of mathematics are less than thirty years of age, and 20 per cent are under twenty-five years of age. The percentage of teachers per five-year-age-group drops markedly after the interval ending with twenty-nine years. No doubt youthfulness, when combined with training, experience, and skill in teaching, is desirable. However, it is doubtful that a large group of young teachers has had the maximum benefit of experience.

The distribution of the years of experience of these teachers is given in Table 9. As already suggested from the ages of these teachers, the table shows that 41 per cent have less than six years of experience, while 62 per cent have less than ten years. This is

direct evidence that teaching mathematics, in the public secondary schools, is not a lifetime profession for a large group of teachers. This rapid turnover which tends to undermine the stability of the profession has one salutary effect, in that it allows innovations to be introduced into the schools much more readily than would otherwise be possible. In so far as the colleges and universities are able to imbue their graduates, who will become teachers, with progressive ideas and in so far as the principals of secondary

TABLE 9

NUMBER OF YEARS OF EXPERIENCE OF MATHEMATICS TEACHERS

Years of experience	Number of teachers	Per cent of total
1-2	739	18
3-5	905	23
6-9	859	21
10-14	611	15
15-19	319	8
20-29	382	9
30-39	150	4
40 and over	30	1
Unaccounted	5	0
Total	4000	100

schools have vision, we may expect our new teachers to be an important medium producing a progressive secondary education. Perhaps this is the greatest source of potential good now operative and perhaps it is also one of the factors of weakness. The teacher-preparation agencies should fully realize their potential power and provide an education which is not only defensible academically, but which also dares progressive pioneering.

The mobility of a group of teachers may be interpreted from a study of the number of different school systems in which they have been employed. Table 10 reveals that approximately 75 per cent of these teachers have been employed in three or fewer systems, and that 32 per cent have taught in only one system. However, these figures are in themselves misleading because they fail to take into account the fact that 61 per cent of these teachers

TABLE 10

THE NUMBER OF DIFFERENT SCHOOL SYSTEMS IN WHICH INDIVIDUAL MATHEMATICS TEACHERS HAVE BEEN EMPLOYED

Number of systems	Number of teachers	Per cent of total
1	1292	32
2	977	24
3	738	18
4	462	12
5	219	5
6	152	4
7	77	2
8	41	1
9	14	0
10	12	0
More than 10	15	0
Unaccounted	1	0
Total	4000	100

have been in service less than ten years. A teacher who works in the profession but a few years naturally has not the opportunity to move from one position to another as frequently as one who remains in teaching for a longer period of time. Mobility in itself is not detrimental to a school system if it is gradual and not disruptive of efficient organization. On the other hand, interchange of teachers may be very wholesome in that it brings to a school new ideas and different teacher backgrounds. The pivotal point in respect to the benefits and liabilities of mobility has not been sufficiently studied. That we live in a world of change can not be doubted. May there not be a danger that the public secondary schools and their teachers are too stable, or does the danger lie in the opposite direction?

The salaries paid to teachers of mathematics in the public secondary schools are practically the same as those paid to teachers of other subjects. The median salary (1931) is between $1500 and $1900, with 41 per cent of the teachers receiving less than $1500. The modal salary, as shown in Table 11, lies within the interval $1000 to $1400. All of these salaries are amounts paid per school year, which usually begins early in September and ends

TABLE 11

SALARY PAID TO TEACHERS OF SECONDARY MATHEMATICS (1931)

Salary in 100 dollars	Number of teachers	Per cent of total	Salary in 100 dollars	Number of teachers	Per cent of total
0-4	22	1	40-44	33	1
5-9	252	6	45-49	36	1
10-14	1385	35	50-54	0	0
15-19	1084	27	55-59	10	0
20-24	609	15	60-64	1	0
25-29	296	7	65-69	0	0
30-34	172	4	70-75	1	0
35-39	88	2	Unaccounted	31	1
Total				4000	100

late in May or the first part of June. The payments are most often made monthly during the time school is in session. There is reason to believe that the low salaries are somewhat responsible for the low levels of age and experience that were revealed in Tables 8 and 9. Not only do women leave the teaching profession to marry, but both men and women leave their teaching positions for more lucrative employment in business. This is particularly noticeable in time of business inflation. The low salaries and direct effects of the business cycle are major elements hindering the more complete professionalization of the teaching staffs of our secondary schools.

TRAINING OF TEACHERS OF SECONDARY MATHEMATICS

There are numerous studies and reports pertaining to the education and training of secondary teachers in the United States. Many of these studies are in the nature of statistical compilations made by the various state departments of education representing the commonwealth in which the data were gathered, while other studies are in the form of theses prepared by candidates for an academic degree in one of the many graduate schools devoted to teacher-preparation.[3] Practically all of these studies concerning secondary teachers have some information directly or indirectly

[3]The terms teacher-training and teacher-preparation are here used interchangeably to mean the educational training and apprentice work leading to legal qualifications for teaching.

pertaining to teachers of mathematics. Several compilations deal exclusively with teachers of mathematics in the public high schools but since these all represent different years they are not directly comparable. However, when a direct comparison with the data of the present study will be illuminative or will serve as a check on the accuracy of the data, such a comparison will be made. Previous studies that bear more directly on the present study are classified in the bibliography. Because of the recency and the completeness of the data herein contained, and because of its apparent reliability, this data should give a fair representation of the training of mathematics teachers.

In this chapter only those items relating to the training of teachers, that are available through a study of the data collected by the National Survey of the Education of Teachers, will be reported. This information is general in scope and presents characteristics of groups of teachers rather than information about specific individuals. In the following chapter, details about teachers' preparation and its effectiveness are given in tables, principally.

The number of years of study beyond high school (Table 12) is one indication of the amount of training possessed by teachers. Eighty per cent of the teachers of secondary mathematics have completed exactly four years of such study. This is the amount usually required for college graduation and for the bachelor's degree, which is often stipulated as a requisite for high school teach-

TABLE 12

THE HIGHEST LEVEL OF TRAINING OF TEACHERS OF SECONDARY MATHEMATICS

Level of training	Number of teachers	Per cent of total
3 years of college	218	5
4 years of college	3193	80
1 year of graduate work	360	9
2 years of graduate work	80	2
3 years of graduate work	80	2
More than 3 years of graduate work	69	2
Total	4000	100

ing. In this connection it should be pointed out that the amount of training does not necessarily imply a type of training which is particularly suitable for teaching mathematics. And furthermore, it should not be assumed that formal study of mathematics in a college assures a great or significant amount of mathematical education. It is entirely possible, as testimony of individual teachers shows, that the mathematics learned by teachers through personal private study while they are teaching, is more significant to them than many of their college courses. The college teachers of mathematics have a responsibility to their students who will become teachers that should not be confused with the responsibility to train future engineers to become mathematical manipulators.

Table 13 shows the number of years these teachers have attended different types of institutions. Because the junior college is a comparatively new type of school unit in this country, not many teachers have had the opportunity to attend such a school. In general, the courses offered in the junior college are similar to

TABLE 13

NUMBER OF YEARS ATTENDANCE IN DIFFERENT TYPES OF EDUCATIONAL INSTITUTION

Number of years in attendance	Number of teachers who attended		
	Junior college	Teachers college or normal school	Other college or university
1	37	175	143
2	118	327	300
3	2	178	202
4	7	726	2138
5		6	235
6		1	68
7			60
8			31
9			3
Unaccounted and non-attended	3836	2587	815
Total	4000	4000	4000

those offered in the first two years of the regular four-year academic college. Although normal schools and teachers colleges have increased notably in number and enrollment, they are still a minor element in the education of secondary teachers. Approximately one-third of the teachers have had some attendance in a normal school or teachers college, but only 18 per cent have spent four years in this type of institution. The major agencies from which secondary teachers are recruited continue to be the college and the university, although these were not organized primarily for teacher-preparation. More than 60 per cent of the teachers of mathematics have had four or more years of training in a college or university, and over 80 per cent have attended more than one year.

The sources of the earned degree are closely related to the types of school attended, and are given for these teachers in Table 14.

TABLE 14

SOURCE OF EARNED DEGREES HELD BY TEACHERS OF SECONDARY MATHEMATICS

Source of degree	Earned degree					
	Bachelor's		Master's		Doctor's	
	Number of teachers	Per cent of total	Number of teachers	Per cent of total	Number of teachers	Per cent of total
State or city teachers college	572	14	10	0		
Private teachers college	34	1	16	0		
State college for women	106	3	1	0		
City college or university	194	5	19	0		
State university or land grant college	815	20	80	2	1	0
Other state-supported college	73	2	5	0		
Private college or university	1937	48	220	6	15	0
No degree shown	269	7	3648	91	3979	100
Unaccounted	0		1		5	
Total	4000	100	4000	100	4000	100

Privately maintained colleges and universities have granted more degrees than all other types of institutions combined. This is specially significant because these schools are not organized primarily for teacher-preparation. The teachers colleges have granted degrees to only 15 per cent of the group while state universities and land grant colleges have conferred bachelor's degrees to 20 per cent, and master's degrees to 2 per cent of the group. Of these teachers, 93 per cent have an earned[4] bachelor's degree, 9 per cent have an earned master's degree, and less than 1 per cent have an earned doctor's degree.

In Table 15 the amount of credit earned in the field of educational theory has been classified according to semester hours of credit. A semester hour is the amount of credit usually given for one class meeting per week during a semester of about sixteen weeks. From the table it is evident that a small percentage of the teachers have less than six semester hours of credit, and only 10 per cent have fewer than thirteen hours of credit. The median number of semester hours of credit for this group is slightly more than twenty. It is interesting to note that over 20 per cent

TABLE 15

THE NUMBER OF SEMESTER HOURS OF CREDIT IN EDUCATIONAL THEORY EARNED BY TEACHERS OF SECONDARY MATHEMATICS

Semester hours of credit	Number of teachers	Per cent of total
No credit	34	1
1-6	106	3
7-12	237	6
13-18	718	18
19-24	1063	27
25-30	701	18
31-40	509	12
41-50	212	5
51-60	83	2
Over 60	155	4
Unaccounted	182	4
Total	4000	100

[4]Earned degrees include such academic degrees as bachelor's, master's, and doctor's degrees which have been granted after the successful completion of some prescribed curriculum. These should be distinguished from honorary degrees.

have more than thirty semester hours of credit, which is the usual amount of credit given for one year of study in a regular four-year college. It is not surprising that practically all of these teachers have had some training in educational theory because all of the states now require this in their teachers' qualifications. Many of the states require a minimum of fifteen semester hours of credit in educational theory with no mention of a maximum. As will be pointed out later, it is a peculiar circumstance that teachers of mathematics are *required* to have training in educational theory but are only *expected* to have training in their teaching field. The assured contributions of educational theory to the training of a teacher of secondary mathematics have not been satisfactorily demonstrated. Further research should seek to isolate and to demonstrate the genuine contributions of the various courses in educational theory to successful secondary teaching, and the optimum amount of this study as well as the desirable means of providing for its fulfillment.

Practice-teaching, in this report, includes such activities as observation of teaching, participation with or helping an experienced teacher, and actually teaching under the supervision of a critic. It may include all, or it may consist of only one of the above. Practice-teaching differs not only with the school in which it is conducted, but also with the individual under whose supervision it is being carried on. Its helpfulness to a teacher in training depends so much upon the facilities for its successful operation that it is impossible to draw any conclusions about its value, without an appraisal of the actual procedure of the work. Because so many of the secondary teachers are being educated in the colleges and universities that are not primarily teacher- preparation institutions, it is doubtful that the practice-teaching done in many of these schools is well organized and adequately supervised. In Table 16 a distribution of the number of semester hours of credit earned in practice-teaching is given. In this table, 22 per cent show no credit and 21 per cent are unaccounted. It is very probable that many of those who are listed as unaccounted, failed to indicate that they had no such credit. Bachman[5] has tabulated twenty-one states that require directed teaching for certification of the highest grade secondary school certifi-

[5]Bachman, Frank P. 1930. Training and Certification of High School Teachers. Field studies No. 2. George Peabody College for Teachers, Nashville, Tenn.

TABLE 16

THE NUMBER OF SEMESTER HOURS OF CREDIT IN PRACTICE-TEACHING EARNED BY TEACHERS OF SECONDARY MATHEMATICS

Semester hours of credit	Number of teachers	Per cent of total
No credit	886	22
1-3	770	19
4-6	938	23
7-12	355	9
13-18	102	3
Over 18	101	3
Unaccounted	848	21
Total	4000	100

TABLE 17

THE NUMBER OF SEMESTER HOURS OF CREDIT, UNDERGRADUATE AND GRADUATE, EARNED IN MATHEMATICS

Semester hours of credit	Number of teachers	Per cent of total
No credit given	368	9
1-9	272	7
10-19	901	23
20-29	1283	32
30-39	767	19
40-49	193	5
50-59	78	2
60-69	42	1
70-79	13	0
80-89	8	0
Over 89	38	1
Unaccounted	37	1
Total	4000	100

cate. The trend is toward further strengthening and more adequately defining the procedures in this type of work.

Unfortunately the data in Table 17 are very general. This table gives the total number of semester hours of credit earned in the field of mathematics but it does not name the specific courses in this field. One other weakness is not so readily apparent; in some of the colleges, especially in teachers colleges, such courses as the "*Teaching of Mathematics*" are given in the mathematics department and are classified as courses in mathematics, while in other schools these are classified as courses in educational theory. The nature and content of such courses differ greatly, depending upon the instructor. No doubt the number of semester hours of credit in mathematics, as listed in the table, would be slightly reduced if only academic mathematics courses were included. However, courses in academic college mathematics do not necessarily insure successful high school teaching. Neither is it proven or disproven that such professional courses as the "*Teaching of Mathematics*" contribute significantly to successful high school teaching.

Table 17 shows that about 40 per cent of these teachers have less than twenty semester hours of credit in the field in which they teach principally. Almost 10 per cent show no credit in this field. Here it should be remembered that this group comprises teachers who teach mathematics principally, and not those who teach mainly in some other field with only one or two classes in mathematics. The optimum amount of academic study for successful teaching is not known, but it seems reasonable to suppose that some such training in college should be necessary. Perhaps our school boards and administrators who engage teachers and assign their teaching schedules know best. They are responsible for the existing situation. Is it possible that in this country we have confused business efficiency with educational leadership to the detriment of the public schools? Perhaps we need more research on the nature and scope of the duties of a school principal and of a school superintendent.

CHARACTERISTICS OF THE TEACHING POSITION HELD BY TEACHERS OF SECONDARY MATHEMATICS

The size of the schools in which these teachers are employed was presented in Table 3. Likewise, the size of the community in

TABLE 18

THE NUMBER OF DIFFERENT FIELDS TAUGHT BY THOSE WHO TEACH MATHEMATICS PRINCIPALLY

Number of fields taught*	Number of teachers	Per cent of total
1	1008	25
2	2438	61
3	409	10
4	107	2
5	25	1
6	7	0
7	3	0
8	1	0
9	1	0
Unaccounted	1	0
Total	4000	100

*Including Mathematics.

which the schools are located was given in Table 4. Although these teachers instruct in mathematics primarily, it is to be expected that some of them, and in small communities perhaps most of them, are teaching in more than one field. Whether or not it is desirable to limit instruction to one field will not be discussed here. Table 18 shows the per cents of these teachers according to the number of fields in which they instruct. One-fourth, or 25 per cent, teach mathematics only, while 61 per cent teach in two fields with mathematics as the major. Combining per cents, 86 per cent teach in less than three fields, and 96 per cent in three or less fields. Obviously it seems necessary for mathematics teachers to be trained in at least one additional field if they are not assured of a position in a large city where only one field of instruction is needed.

It is interesting to note the various fields that are combined with mathematics. Table 19 lists these alphabetically and shows the per cents of teachers who are giving instruction in each of these fields, combined with mathematics as the major teaching field. The most frequent combination with mathematics is physical sciences. Since 22 per cent of the total combinations are

with physical science, and 6 per cent are with biological science, these two groups approximate one-third of all the combinations. The next most prevalent combinations are with social studies (history, sociology, and economics) and English respectively. The other combinations are scattered among ten different fields and are of minor interest. The number of English and social studies teachers is actually greater than the number of either mathematics or science teachers in the average high school, therefore the frequency of combinations with these fields is less noticeable than it would otherwise be. Because many of our public high schools are small, it is apparent that we shall continue to need some teachers who are qualified to instruct in more than one field. Furthermore, it may be highly desirable for secondary teachers to be interested in several fields. This may be conducive to a type of secondary education superior to that produced by teachers who are narrow specialists. If combinations of teaching fields are necessary, and if there is a possibility that they may even be de-

TABLE 19

THE NEXT MAIN, OR MINOR, TEACHING FIELD OF THOSE WHO TEACH MATHEMATICS PRINCIPALLY

The next main field of teaching	Number of teachers	Per cent of total
Agriculture and forestry	24	1
Art and drawing	11	0
Biological sciences	237	6
Business and commerce	99	2
Education and teacher training	55	1
English	381	10
Classic languages	210	5
Modern languages	193	5
Health and physical education	113	3
Home economics	22	1
Physical sciences	890	22
Music	35	1
History, sociology, economics	650	16
Trades and industrial arts	32	1
Non-listed subjects	27	1
No next main field and unaccounted	1017	25
Total	4000	100

sirable, we should seek to discover which combinations are of greater worth. It is not impossible to suppose that the kind of thinking in social studies is less similar to that in mathematics, than the thinking found in the physical sciences. The similarity of teaching fields depends not alone upon content, but also upon the methods of teaching and learning that are employed.

RELATIONSHIP OF FACTORS PREVIOUSLY DESCRIBED

The data heretofore presented have been descriptive of certain definite characteristics of the teachers of secondary mathematics. Relationships between these characteristics are not only more interesting than the simple descriptive data but they are also useful in showing trends within the group. Only the studies of relationships that are more significant to the present study have been reported. These include a comparison of the highest level of training of teachers to such other factors as the size of the community in which the school is located, the number of years of teaching experience of the group, and the age of the teachers. The number of semester hours of credit earned in mathematics by these teachers has been compared with the source of the bachelor's degree, and to the number of years of teaching experience. These are presented in tables and figures with brief descriptions of the more significant features.

Table 20 has been prepared to show the details of a distribution of the frequencies of various levels of training attained by teachers who are located in different sizes of community. In general, teachers having fewer years of training are found in smaller communities. However, those having only three years of college training are well distributed in both small and large communities. The group having four years of college training (this group is 75 per cent of the total) has 40 per cent of its number teaching in communities of less than 2500 population. In the main, those teachers who have graduate training are located in the larger cities. No doubt the higher salaries paid to teachers in these urban centers are somewhat responsible for the higher levels of training of their teachers. Large cities not only require more training and experience before accepting new teachers into their systems than do smaller communities, but more often they have within their confines educational institutions offering advanced work for teachers.

TABLE 20

HIGHEST LEVEL OF TRAINING OF TEACHERS AND THE SIZE OF THE COMMUNITY IN WHICH THEY TEACH

Training of teacher	Number of teachers in community						
	Open country	Population to 2500	Population to 9999	Population to 99,999	100,000 and more	Unaccounted	Total
Three years of college	22	96	26	30	40	4	218
Four years of college	207	1199	601	674	492	20	3193
One year of graduate work	10	60	48	103	139	0	360
Two years of graduate work	3	5	9	16	46	1	80
Three years of graduate work	2	3	4	12	57	2	80
More than three years of graduate work	1	4	3	5	55	1	69
Totals of columns	245	1367	691	840	829	28	4000

Reading across this table, teachers with three years of college training are distributed thus: 22 are in the open country, 96 are in villages with population up to 2500, 26 are in cities ranging from 2500 to 9999 population, etc., for each cross row. Similarly, the columns may be read down; in the open country, 22 teachers have three years of college education, 207 have four years of college education, etc., for each column.

Table 21 and its derivative, Figure I, show the various amounts of teaching experience possessed by teachers who have different levels of training. Attention is called to the general trend for teachers having four or more years of experience. There is a definite positive correlation between the number of years of experience and the number of years of training. Also, the group of teachers with four years of college training is the group having the lowest median level of experience. This is apparent from Figure I, which

shows that this group is also the one having the lowest median age. These are the teachers recently graduated from college. They come and go, producing instability in the profession. It is not amazing that so many teachers of mathematics remain in the profession for such a short time when we recall that more than 60 per cent of them have received their education in an institution that is not primarily organized for teacher-preparation. These graduates from the standard non-professional colleges find high school teaching a profession easily entered because of the relatively high teacher turnover. They teach a few years and then seek

TABLE 21

HIGHEST LEVEL OF TRAINING POSSESSED BY TEACHERS WITH A GIVEN NUMBER OF YEARS OF TEACHING EXPERIENCE

Training	Number of teachers									
	Years of experience								Unaccounted	Total
	1-2	3-5	6-9	10-14	15-19	20-29	30-39	40-49		
Three years of college.....	10	41	32	39	28	35	24	9	0	218
Four years of college.....	706	801	685	444	217	241	84	12	3	3193
One year of graduate work	18	52	107	72	40	52	14	3	2	360
Two years of graduate work	3	6	11	23	14	15	8	0	0	80
Three years of graduate work	2	3	15	18	11	17	11	3	0	80
More than three years of graduate work	0	2	9	15	9	22	9	3	0	69
Totals of columns.....	739	905	859	611	319	382	150	30	5	4000

Reading across this table, teachers with three years of college training are distributed thus: 10 have taught 1-2 years, 41 have 3-5 years of experience, etc. Similarly, the columns may be read down; in the 1-2 years experience group, 10 have had three years of college work, 706 have had four years of college work, 18 have an additional year of graduate work, etc., for each column.

THE MEDIAN NUMBER OF YEARS OF TEACHING EXPERIENCE AND THE MEDIAN AGES OF MATHEMATICS TEACHERS WHO HAVE VARIOUS LEVELS OF TRAINING.

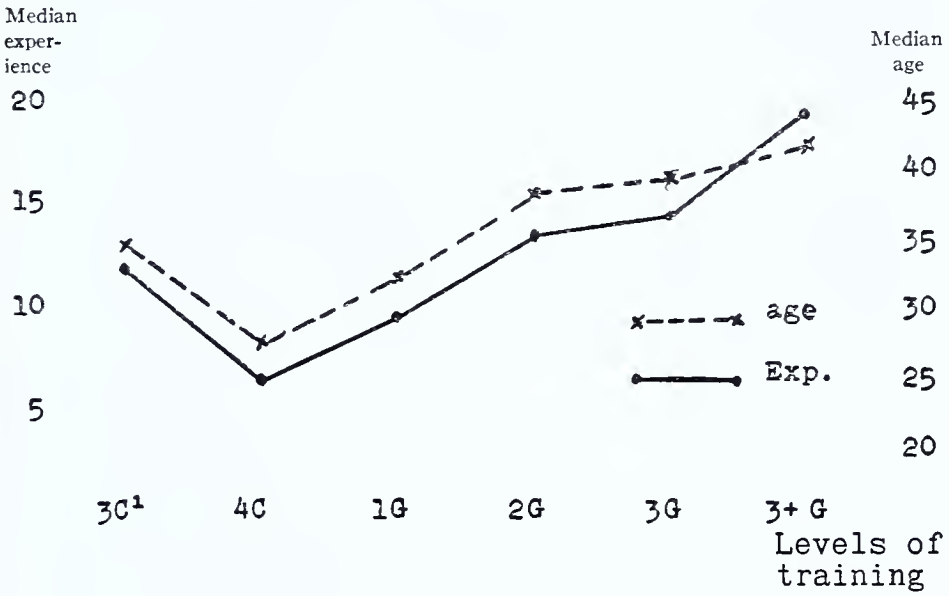

FIGURE I

In reading this graph, experience and age should each be read independently from the respective scale for each.

[1]3C and 4C mean three and four years of college training respectively and 1G etc., means years of graduate work as in Table 21.

new careers in marriage, business, or other non-teaching fields. Furthermore, the salary paid to a person who enters teaching is high as compared with the salary paid to an inexperienced person in other fields, and to experienced persons in the same field. This system could be corrected in part through the creation of a system of apprentice-teaching for graduates of colleges.

While progress is in itself wholly commendable, mere change should not be interpreted as progress. Any criticism that is directed at the teaching population should be directed not only at the agencies preparing teachers, but also at the school officials who are actually selecting the teachers now in service. In the final chapter of this report, some recommendations designed to alleviate undesirable current practices are given.

Table 22 shows the relationship between the age of teachers and the different levels of training attained by them. The distribution in Table 22 is made more intelligible in Figure I which

incorporates the information of both Tables 21 and 22. Because of the inherent relation between age and experience, it is to be expected that the line representing median ages should closely resemble the line of median years of experience. Those teachers who have had exactly four years of college training have the lowest medians in both age and experience, while those having more training are older and more experienced. Inasmuch as the teachers having only three years of college training (beyond high school) are a small minority with a median age of thirty-five years, and since the new teachers generally have had four years of college training, it appears that this minority group will gradually disappear. We need not be greatly disturbed by the meagerness of

TABLE 22

AGE OF TEACHERS AND THE HIGHEST LEVEL OF TRAINING ATTAINED BY THEM

Age	Number of graduates						
	Years of college		Years of graduate work				
	Three	Four	One	Two	Three	More than three	Total
20-24.....	30	751	19	3	3	0	806
25-29.....	44	1076	85	10	4	5	1224
30-34.....	32	562	90	18	16	11	729
35-39.....	29	320	58	10	18	12	447
40-44.....	21	184	46	13	12	9	285
45-49.....	20	143	34	14	7	7	225
50-54.....	21	80	15	5	12	10	143
55-59.....	10	48	6	3	4	8	79
60-64.....	9	20	4	4	3	5	45
65 and over ..	2	7	1	0	1	2	13
Unaccounted	0	2	2	0	0	0	4
Totals of columns.....	218	3193	360	80	80	69	4000

Reading across the table: from the age group 20-24, 30 teachers have three years of college training, 751 have four years, 19 have one year of graduate study, etc., through each age group. Reading down the column: of the teachers having four years of college training, 751 are between ages 20-24, 1076 are between ages 25-29 inclusive, etc., down each column.

training of this group. Through accumulated experience, they probably have more mastery of the immediate subject matter and the techniques of teaching than the new teachers will acquire for several years. Furthermore, evolution is apparently in control of the situation in this group. Our greatest concern should be with the adequate preparation of the new teachers who are constantly entering the profession.

In Table 23, distributions of the number of semester hours of mathematics credit are given for teachers who have earned their bachelor's degree in various types of educational institutions. Figure II, which has been derived from Table 23, shows various percentiles of the number of semester hours of credit earned in mathematics by these same teachers. The medians (50 percentiles) are surprisingly close. The teachers who have received their first degrees from teachers colleges have almost as much credit in mathematics as do teachers educated in other types of institutions. Here we should recall the fact that in teachers colleges such courses as the *teaching of mathematics* are commonly found in the mathematics department and that the nature of such courses is not as well-defined and standardized as are such courses in academic mathematics as *analytical geometry.* In some schools, such professional-mathematics courses as the teaching of algebra are highly mathematical in content, in others they are almost wholly a body of educational theory applied to the teaching of mathematics. No real attempt has yet been made to determine the optimum relationship between the two types of courses, the academic and the professional mathematics, in terms of their contributions toward the training of a desirable type of teacher of secondary mathematics. No doubt both types of courses have distinct and significant contributions which should be merged rather than overlooked.

Since the teachers prepared in "other state colleges" comprise less than 2 per cent of the total, the fact that this group has the least amount of mathematical training is not of great concern. However, these schools (i. e., state schools of mines, agriculture, home economics, etc.,) are professional schools of a non-teacher-preparation type and perhaps should not educate any teachers of mathematics.

Because the private colleges and universities have granted more degrees to teachers of secondary mathematics than all other

types of school combined, this type is of the greatest importance in the present study. The median (50 percentile) for this type is approximately twenty-two semester hours. This amount is near the average of the medians for the remaining types of schools. The 12½ percentile shows that one-eighth of this group of teachers

TABLE 23

THE RELATIONSHIP BETWEEN THE AMOUNT OF CREDIT IN MATHEMATICS AND THE SOURCE OF THE BACHELOR'S DEGREE

Source of degree	Number of teachers										
	Semester hours in major (mathematics) field									Unaccounted	Total
	None	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79		
State or city teachers college	85	26	102	183	134	24	6	5	3	4	572
Private teachers college	5	1	8	11	6	1	1	1	0	0	34
State college for women	9	12	18	41	18	4	1	0	1	2	106
City college or university	20	13	33	48	45	11	10	1	9	4	194
State university or land grant college	45	59	177	261	181	47	23	9	11	2	815
Other state supported college	11	6	22	21	8	4	0	0	0	1	73
Private college or university	119	119	469	670	361	97	33	25	32	12	1937
Unaccounted	74	36	72	48	14	5	4	1	3	12	269
Totals of columns	368	272	901	1283	767	193	78	42	59	37	4000

This table is similar to preceding tables and is interpreted in the same manner.

THE 12½, THE 25, THE 50, THE 75, AND THE 87½ PERCENTILES OF THE NUMBER OF SEMESTER HOURS OF CREDIT IN MATHEMATICS EARNED BY TEACHERS GROUPED ACCORDING TO THE SOURCE OF THEIR BACHELOR'S DEGREE.

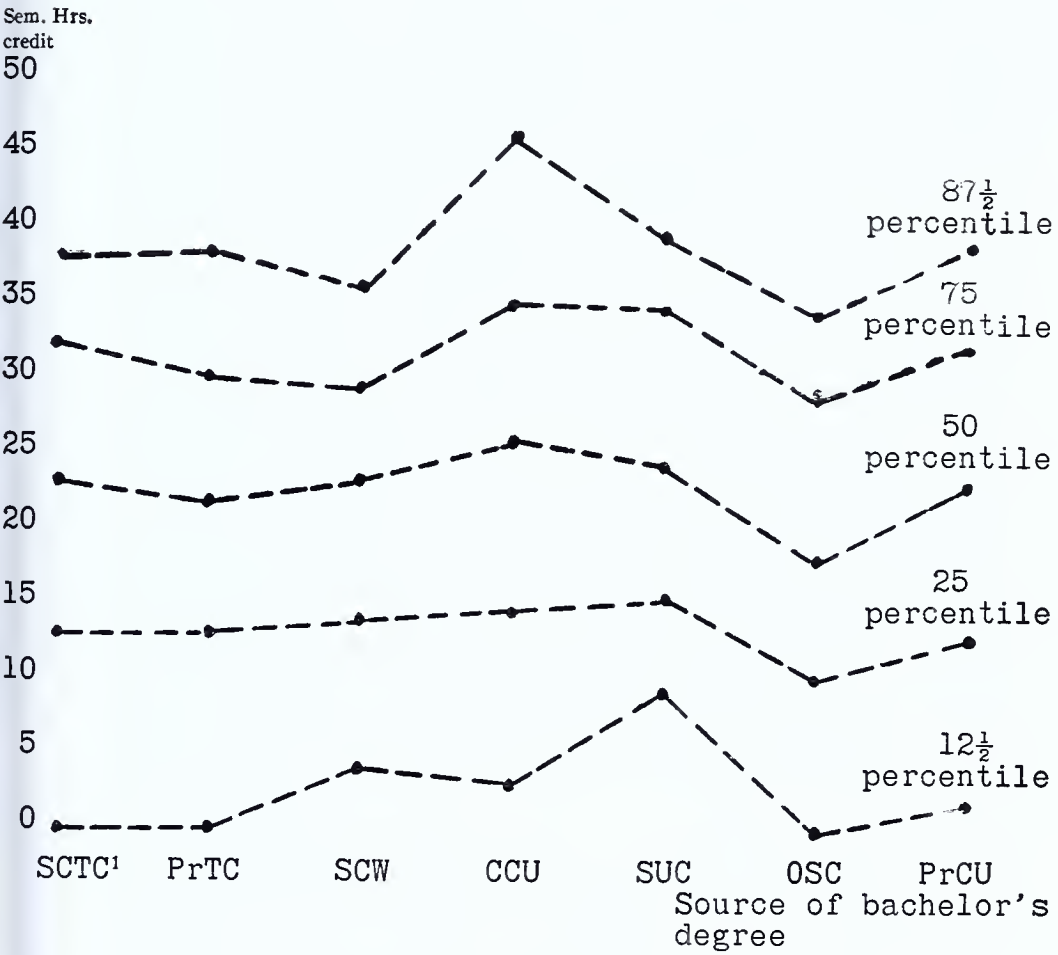

FIGURE II

In reading this graph, it should be recalled that the points showing each percentile for different types of school, while unrelated, have been joined by a broken line so that comparisons may be more easily made.

[1]SCTC means state or city teachers college
Pr TC — private teachers college
SCW — state college for women
CCU — city college or university
SUC — state university or land grant college
OSC — other state-supported college
Pr CU — private college or university

has earned only two semester hours of credit in their principal teaching field, while the 25 percentile shows that one-fourth of them have earned less than fourteen semester hours of credit.

The middle one-half of the teachers in each group are found between the 25 and the 75 percentiles. Similarly, the middle three-fourths of them are found between the 12½ and the 87½ percentiles, respectively. An inspection of Figure II shows no great differences in amounts of variability in the several groups. The medians are in all cases very near the mid-point of the interval between the 25 and the 75 percentiles, and relatively near the mid-point between the 12½ and the 87½ percentiles. The 12½ percentile shows, with one exception, that one-eighth of the teachers in each group have less than five semester hours of credit in mathematics, and that in three of the groups this percentage of the teachers has earned no credit in this field. On the other hand, the 87½ percentile shows that with one exception seven-eighths of the teachers have less than forty-five semester hours of credit in mathematics. In this country, study in mathematics amounting to a credit of twenty semester hours usually implies courses in algebra, geometry, trigonometry, and differential and integral calculus. Is this level, which is now the approximate median for our teachers of secondary mathematics, a sufficient median or should it be a minimum goal? When is a teacher properly prepared in her field? In seeking the answers to these questions an educational philosophy must be established and sagaciously interpreted.

In order to determine whether the more-experienced or the less-experienced teachers had studied more in the field of mathematics, Table 24 was prepared. The data from this table has also been translated into Figure III which shows the 25, the 50, and the 75 percentiles of the number of semester hours of credit in mathematics earned by teachers who have various levels of teaching experience. In general, those teachers who have less experience, and who are consequently newer in the field and younger, have more credit in the subject they teach than do the more experienced teachers. Yet the median number of semester hours of credit for teachers having only one or two years of experience is less than five semester hours more than the credit possessed by teachers who have up to thirty years of teaching experience. Those who have taught more than thirty years have rapidly de-

creasing amounts of credit with the median for those who have taught from forty to forty-nine years at the low point of eight semester hours. Again, the newer teachers have more academic training than the older ones, the older teachers are gradually retiring from the profession, and hence our standards of training are moderately being raised. We have no positive assurance that the larger amount of academic training, now possessed by high school teachers before entering the profession, is of any better quality than that received by their predecessors.

TABLE 24

THE NUMBER OF YEARS OF TEACHING EXPERIENCE AND THE NUMBER OF SEMESTER HOURS OF CREDIT IN MATHEMATICS

Semester hours credit	Number of teachers									
	Years of experience								Unaccounted	Total
	1-2	3-5	6-9	10-14	15-19	20-29	30-39	40-49		
0.....	31	38	56	64	43	73	48	14	1	368
1- 9.....	46	60	55	46	21	30	12	1	1	272
10-19.....	156	212	188	158	77	79	28	3	0	901
20-29.....	275	329	292	176	96	88	23	2	2	1283
30-39.....	177	194	181	100	44	54	15	1	1	767
40-49.....	38	40	41	28	16	25	4	1	0	193
50-59.....	3	17	21	12	8	12	3	2	0	78
60-69.....	9	9	6	7	3	3	5	0	0	42
70-99.....	3	4	13	14	6	11	7	1	0	59
Unaccounted	1	2	6	6	5	7	5	5	0	37
Totals of columns.....	739	905	859	611	319	382	150	30	5	4000

Reading across this table, teachers with zero semester hours of credit in mathematics are distributed thus: 31 have taught 1-2 years, 38 have taught 3-5 years, 56 have taught 6-9 years, etc. Reading down the columns, those who have taught 1-2 years: 31 have no credit, 46 have 1-9 semester hours of credit in mathematics, 156 have 10-19 hours, etc.

THE 25, THE 50, AND THE 75 PERCENTILES OF THE NUMBER OF SEMESTER HOURS OF CREDIT IN MATHEMATICS EARNED BY TEACHERS WHO HAVE VARIOUS LEVELS OF TEACHING EXPERIENCE.

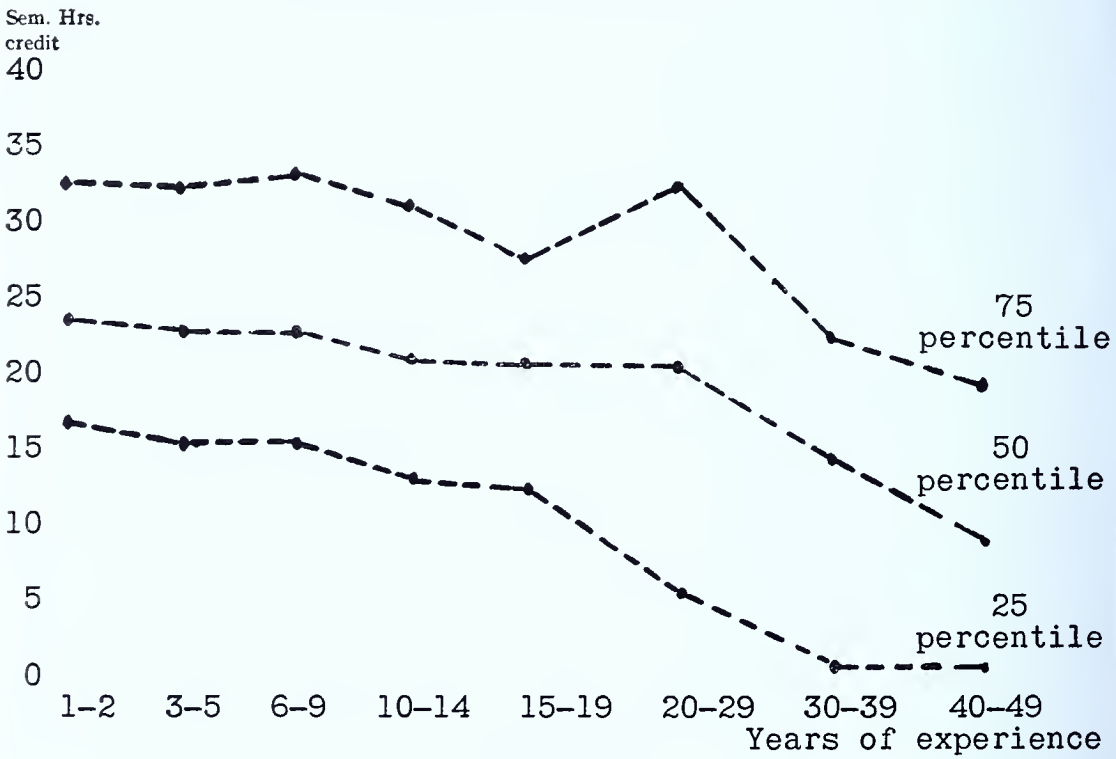

FIGURE III

SUMMARY

1. The data presented in this chapter represent a sample of 4000 teachers, from the District of Columbia and forty-six of the forty-eight states, who teach mathematics wholly or principally in the senior high schools of the United States.

2. Approximately 40 per cent of the teachers are employed in communities having less than 2500 population; another 40 per cent are employed in communities of 10,000 or more, while the remaining 20 per cent teach mainly in communities ranging from 2500 to 9999 in population.

3. The median size of the school in which these teachers are employed is one having between ten and fourteen teachers.

4. Single women constitute 48 per cent of this group of teachers, married men form 26 per cent, and the third largest group is that of single men who comprise 17 per cent of the total.

5. The median age of these teachers of mathematics is in the upper twenties. Twenty per cent of them are less than twenty-five years of age and 20 per cent are more than forty years old.

6. Of this group, 40 per cent have had five or less years of experience and more than 60 per cent have less than ten years of teaching experience.

7. About 55 per cent of these teachers have done all of their teaching in one or two school systems while approximately 13 per cent have been employed in five or more systems.

8. The annual salaries paid to teachers of high school mathematics range from less than 500 dollars to more than 7000 dollars, with the median and the mode located near 1500 dollars.

9. Four years of college training has been attained by 80 per cent of these teachers. Fifteen per cent have done graduate work, and 5 per cent have had only three years of training beyond high school.

10. Very few of these teachers have attended a junior college. About 30 per cent have attended a normal school or teachers college, and 80 per cent have attended some other type of college or university. Many teachers have attended several types of institution.

11. Private colleges and universities have issued more bachelor's, master's, and doctor's degrees to senior high school teachers of mathematics than all other types of school combined.

12. The median number of semester hours of credit in educational theory for this group of teachers lies within the interval 19-24 hours.

13. More than 20 per cent of this group show no credit in practice-teaching, 20 per cent have earned from one to three semester hours of credit in this subject, and 23 per cent have had between four and six hours of similar study.

14. The amount of credit earned in the field of mathematics ranges from zero to more than ninety semester hours, with the central tendency between twenty and twenty-five semester hours. About 40 per cent have had less than twenty semester hours of credit in their principal teaching field, while almost 10 per cent have no credit in this field.

15. Twenty-five per cent of the group teach only mathematics, 61 per cent teach mathematics and one other field, and the remaining 14 per cent teach in three or more fields.

16. One-third of the group, who teach in more than one field, are combining mathematics with some form of physical or biological science. The next most common combinations with mathematics are social studies and English respectively.

17. In general, those teachers who possess the most training are located in the largest communities. However, the teachers having only three years of training beyond high school are distributed in all sizes of communities. Forty per cent of those having four years of college training are found in communities of less than 2500 population.

18. Generally, the older and most experienced teachers have more training than the young and less experienced teachers. The teachers who have only three years of college training however, have a higher median experience than either those having four years of college or those having one year of graduate study. The teachers with four years of college training have the lowest median age level.

19. The median number of semester hours of credit earned in mathematics ranges between eighteen and twenty-six for all types of schools that have granted bachelor's degeees to these teachers. While teachers colleges compare favorably with other types of schools, it should be remembered that some of their work in the field of mathematics is in the nature of professional courses. Twelve and one-half per cent of the teachers who have received bachelor's degrees in teachers colleges, and an equal per cent who were trained in state-supported schools other than state universities or land grant colleges, have earned no credit in mathematics.

20. As a whole, the less experienced teachers have more credit in the field of mathematics than do the more experienced ones. The teachers having more than thirty years of experience possess much less credit in the field of mathematics than do the less experienced teachers.

21. The relatively low median number of years of teaching experience implies a high teacher turnover which is due to young teachers remaining in the profession for only a short time.

22. Older teachers are gradually being replaced by younger teachers who have a higher median level of training.

CHAPTER IV

THE EDUCATIONAL AND EXPERIENCE BACKGROUNDS OF TEACHERS OF SECONDARY MATHEMATICS

INTRODUCTION

Although the scope of this chapter is similar to that of the preceding one, the data are much more detailed. Chapter three was based upon an analysis and study of the information collected by the National Survey of the Education of Teachers. This survey covered both elementary and secondary education and for this reason minuteness of detail had to be sacrificed for breadth and inclusiveness. In order to gain a more comprehensive picture of the academic and professional training backgrounds of the teachers of secondary mathematics, as well as a more adequate description of the various types and amounts of experience of these teachers, further information was necessary. This was collected by means of an auxiliary survey conducted under the joint auspices of the National Survey of the Education of Teachers and the American Committee of the International Commission on the Teaching of Mathematics. The two surveys were conducted independently. However, they overlap in several elements, particularly in respect to the academic degrees held by teachers of senior high school mathematics and in the amount of study in the field of educational theory. The similarity of data in these two overlapping elements is striking and tends to confirm the belief that the data of both surveys are representative.

While chapter three concerns only senior high school teachers of mathematics, the material reported in this chapter represents both junior and senior high school teachers of the subject. Here as previously, the term senior high school includes not only the usual senior high school of the reorganized type, but also the regular non-reorganized high school that immediately follows the elementary school.

Because this auxiliary survey includes a different, although apparently a similar, sample of teachers and because it was conducted one year later than the National Survey, it was considered advisable to present the data in a separate section rather than to confuse the two bodies of data in one section. The inquiry form used to collect this information has already been described in chapter two and appears in the appendix, labeled Form C. As heretofore, the data from this later survey has been presented in tables which have been analyzed and described. The more salient and important items are noted and again summarized at the end of the chapter.

The data of this chapter represent teachers of both junior high school and senior high school mathematics in all of the states and the District of Columbia. All sizes of communities, ranging from the largest city to small villages in each state, are included in the 1049 replies received. Only three of the replies showed lack of carefulness in preparation and fourteen others were not tabulated because they were incomplete, i. e., the teachers supplied information on one side only of the two-page question sheet. The remaining 1032 replies represent 269 junior high school teachers and 763 senior high school teachers. The relatively small number of junior high school teachers is due to the small number of such schools in the country.

COURSES IN MATHEMATICS STUDIED BY TEACHERS

In the preceding chapter, the amount of study in the field of mathematics earned by teachers of that subject was shown in terms of the number of semester hours of credit earned in colleges by these teachers. A summary of the data has been given in Table 17. In the auxiliary inquiry, upon which chapter four has been based, teachers were asked not only to check the courses in high school and college mathematics which they have formally studied, but also to give the amount of credit earned in each course. In analyzing these responses it was found that the amount of credit for the same course differed widely. For example, the subject of *college algebra*, which in this country is a rather well-defined body of material, has been given credits ranging from one to ten semester hours with a central tendency of three and four semester hours. Other course credits differ significantly but not as widely as *college algebra*. This extensive range

of credit assignments also represents a period of time designated as about 1890 to the present time. Recent graduates from educational institutions show a greater similarity in the amounts of credit assigned to particular courses. With these facts in mind, it has been necessary to again decide whether the amount of study in academic mathematics should be given in terms of courses, or in terms of semester hours of credit. Because of the rather definite body of materials in most of the college courses, and because the material in the preceding chapter was presented in terms of semester hours of credit, it was decided that the better method to employ in this chapter would be in terms of courses studied.

In high school mathematics, credit is usually assigned in terms of units where one unit is defined as one school year of study (usually 36 weeks) on one subject, with five forty-five, or fifty-minute class recitation periods per week. The subjects studied in high school by this sample of teachers are shown in Table 25.

Table 26 shows a distribution of the teachers in terms of units of credit earned in the study of high school mathematics. There is much similarity in these two tables because the units of credit assigned to various courses in Table 25 are very constant throughout the country. *Elementary algebra* and *plane geometry* are usually given in the first and second years of the typical four-year high school, and each course is most often assigned one unit of credit. The other high school mathematics courses are usually credited with one-half unit each. It is obvious that if a pupil has earned more than four units of credit in the ordinary four-year high school, it was necessary for him to pursue two courses in mathematics at the same time during some part of his school career. Our high schools usually prescribe certain courses so that a pupil does not specialize in any one field to the exclusion of several other fields. Four such units of credit as have been described, constitute a normal year's work in a typical high school. Table 25 shows that practically all of the teachers of secondary mathematics have studied one year of algebra and one year of geometry in their own secondary school career. The reason for this is not alone the pupils' choice, but the fact that these two subjects are prescribed in the curricula leading to high school graduation. The table shows that 65 per cent of the junior high school teachers, and 91 per cent of the senior high school teachers have studied *solid geometry.* *Solid geometry* is occasionally

taught in the college, but since it is most often taught in the high school it has been listed here with other typical high school courses. *Trigonometry* has been studied in the high school by more of the younger teachers than the older ones. While *trigonometry* was considered a study of strictly college grade thirty years ago, it is now found entirely suitable for high school seniors who possess a fair background in mathematics and an ordinary amount of intelligence.

TABLE 25

THE HIGH SCHOOL MATHEMATICS COURSES STUDIED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Courses	Usual credit units	Jr. H. S. teachers		Sr. H. S. teachers	
		Number	Per cent	Number	Per cent
Elementary algebra	1	268	100	757	99
Intermediate algebra	½	217	81	692	91
Advanced algebra	½	74	27	258	34
Plane geometry	1	257	96	746	98
Solid geometry	½	174	65	639	91
Trigonometry	½	39	15	141	18
Arithmetic and others		7	3	26	3
Number of teachers		269	100	763	100

TABLE 26

THE NUMBER OF UNITS OF CREDIT IN HIGH SCHOOL MATHEMATICS EARNED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Unit of credit	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
0	3	1	0	0
.1—1	5	2	3	0
1.1—2	35	13	34	5
2.1—3	135	50	353	46
More than 3	91	34	373	49
Total teachers	269	100	763	100

The nature of this course has changed sufficiently so that it is more palatable for young minds. The most striking revelation in Table 25 is that the junior high school teachers of mathematics have almost as good a background in secondary mathematics (as shown in courses studied by them) as do the present teachers of senior high school mathematics. Table 26 shows that almost half of the senior high school teachers have more than three units of credit in high school mathematics. The typical program of studies includes *elementary algebra* (1 unit), *plane geometry* (1 unit), *intermediate algebra* (½ unit, *solid geometry* (½ unit) or *advanced algebra* (½ unit). Half of the junior high school teachers have more than two, but not more than three units of credit in this field. Both groups of teachers exhibit central tendencies near three units of credit, which as previously stated, implies three years of study in the field of mathematics.

In Table 27, the more common undergraduate and graduate courses in academic mathematics, as well as several applied courses, have been listed together with the number and the per cents of junior and senior high school teachers of mathematics who have studied each of the courses. These courses are listed somewhat in the order in which they are usually studied rather than in the order of frequency of study. *General mathematics* and *elementary mathematical analysis* are courses that are being given in an increasing number of colleges to take the place of the more traditional courses in *college algebra* and *trigonometry*, which for a long time constituted the work in mathematics of the first college year. It is possible that a small group of teachers have been credited in both general mathematics and college algebra, although in most cases the one excludes the other. It is also possible that some of the teachers have a duplication of work in the *advanced algebra* of the high school and the *college algebra* of the first year of college.

While more and more colleges are refusing to grant credit for *college algebra* to students who have had *advanced algebra* in an accredited high school, there are still a number of colleges that do feel that *advanced algebra* is comparable with *college algebra*. No estimate of the comparative value of the two types of courses (general and separate) for college freshmen can here be given. The evidence, as given by college teachers who have taught both types, is conflicting. Yet it should be pointed out that since it

is the younger teachers who have had *general mathematics*, there is evidence that this move has been growing during the past decade. That 28 per cent of the junior high school teachers have had *general mathematics* and only 15 per cent of the senior high school teachers have studied the course, is due to the different types of educational institutions from which these two groups of teachers have been recruited. A larger percentage of the junior high school teachers have come from normal schools and teachers colleges than is the case with senior high school teachers, and apparently those institutions are more commonly offering the *general mathematics* course than are the typical colleges and universities from which the majority of the senior high school teachers are graduated.

The junior high school teachers compare favorably with senior high school teachers in respect to the amount of mathematics studied when measured in terms of the first two courses which usually constitute one year of work. After that, the junior high school teachers fall noticeably below the other group. For example, in the subject of *plane analytic geometry*, only 44 per cent of the junior high school group has credit in this course while 80 per cent of the senior high school teachers possess such credit. The courses studied by 30 per cent or more of the senior high school group includes *college algebra, trigonometry, plane analytic geometry, calculus, theory of equations, history of mathematics, astronomy,* and *college physics.* While the last three of these are strictly academic courses in mathematics, they are so closely related that their inclusion is warranted. Among the junior high school teachers, only *college algebra, trigonometry, plane analytic geometry,* and *college physics* have been studied by 30 per cent or more of the group. It is gratifying to note that 55 per cent of all the senior high school teachers have studied the related courses of *college physics.* Several other non-listed courses such as *differential geometry, point set, higher plane curves,* etc., have been studied by 7 per cent of the junior high school teachers and by 12 per cent of the senior high school teachers.

In chapter three, it was stated that 9 per cent of the senior high school teachers had no earned credit in academic college mathematics, and in the data just described only 5 per cent of the group have no such credit. This discrepancy can not be explained exactly. Some of it may be due to errors of sampling

and no doubt much of it is due to a confusion between *triogonometry* and *college algebra* in high school and in college. Many of the high schools actually use *college algebra* text-books for their *advanced algebra.* On the inquiry form both *trigonometry* and *algebra* were listed with typical high school courses and also with college mathematics courses. No doubt this resulted in some confusion. In all cases where this confusion could be clarified when the data was tabulated, this was done. In general, the agreement between the two bodies of data is remarkably close.

It is difficult to determine what constitutes an adequate academic background of courses for successful and intelligent teaching of mathematics in the secondary school. Successful teaching is dependent upon the criteria by which it is judged. These criteria may be either, or both, extra-mural and intra-mural with respect to the individual school. In the eastern part of the United States such extra-mural influences as the New York State Regent's examinations and the examinations set by the College Entrance Board are powerful agencies not only influencing the content of secondary mathematics courses but furnishing convenient bases by which school officials judge the success of their teachers. The extent and the earnestness in the use of these criteria by school officials and the laity is apparent from the following not infrequent observation, "Miss Blank is one of the finest teachers in this section, ... for the past five years she has had only two pupils fail the Regents examination in *geometry.*" Upon investigation, it was found that this teacher had at no time during her career received any credit for any academic courses in mathematics that are now commonly taught in college. Her preliminary training was completed in a normal school prior to 1890 and since then she has studied for two summers in non-mathematical fields. In other words, it is entirely possible for a teacher of secondary mathematics to be very successful in having pupils pass an examination, when she herself possesses only a meager amount of formal education in the field. In this same state, a young man was invited to teach *geometry* merely because he was a good disciplinarian and in spite of the fact that he had studied no academic mathematics beyond that which he was invited to teach. By the above criterion for measuring teaching

success, he too would have been successful as a teacher of *geometry*. Patently, an extra-mural examination is at best only a partial measure of a teacher's ability to teach. It is really a measure of the teacher's ability to persuade the pupils to master a body of information sufficient unto the typical pattern of the examination.

Teaching of mathematics is truly successful and intelligent when it results not merely in pupils learning to reproduce a given body of facts and theorems, but rather and of far greater importance, when the pupils learn to discover, to think with, and to expand the mathematical relationships with which they are dealing. The manipulation of symbols should not be the ends sought, rather this should be considered the means by which mathematical thinking is facilitated. If a teacher is to provide the mental stimulation that will produce that type of mathematical learning, it is necessary that he himself has studied more than the specific courses that he teaches. True, examinations that measure real mathematical thinking have not yet been constructed, but pioneer work is being done in this direction. The college courses studied by teachers of secondary mathematics should not only extend the mathematical education, but should augment and enrich a background for the courses which these students will be required to teach. From Table 27, it is apparent that the courses most often studied in college are algebraic, not geometric, in nature. Only 19 per cent of these teachers have studied *modern geometry*, and a very small group of them have listed a course in *college geometry* because few schools offer the subject. Several text-books for this course are now available and educational institutions are offering it to their students. The contributions of this course to a secondary teacher should be of great importance because it offers an opportunity to augment and extend the *geometry* taught in the secondary school. A course which is usually called *fundamental concepts in mathematics* was listed by a small group of teachers. Following the piece-meal courses offered in the typical college, this last-named course should serve as an integrating course and should contribute significantly to the education of a teacher of secondary mathematics. As will be pointed out later, not only the content of the mathematical education received by the prospective teacher in collge, but also the philosophy determining the methods of that teaching are both important.

The normal schools and teachers colleges, because they are professional schools maintained for the sole purpose of training teachers for the elementary and secondary schools, have for several decades been providing courses in professional mathematics. These aim primarily to acquaint the student with methods of

TABLE 27

THE ACADEMIC COLLEGE MATHEMATICS COURSES STUDIED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Courses	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
No courses studied	26	10	38	5
General mathematics (1st yr.)	76	28	112	15
Mathematical analysis (1st yr.)	34	13	64	8
Mathematical analysis (2nd yr.)	13	5	32	4
College algebra	164	61	602	79
Trigonometry	152	57	603	79
Plane analytic geometry	117	44	612	80
Solid analytic geometry	40	15	224	29
Calculus (differential and integral)	75	28	555	73
Theory of equations	28	10	250	33
Theory of numbers	14	5	73	10
Differential equations	18	7	202	26
Advanced calculus	23	9	128	17
Theory of groups	4	1	14	2
Vector analysis	3	1	26	3
Descriptive geometry	13	5	111	15
Modern geometry	17	6	146	19
History of mathematics	42	16	229	30
Astronomy	47	17	232	30
Mathematical statistics	30	11	107	14
Mathematics of finance	19	7	81	11
Mechanics	10	4	111	15
Surveying	16	6	139	18
College physics	92	34	419	55
Other courses	19	7	89	12
Total number of teachers	269		763	

teaching the various subjects or courses in mathematics. For elementary teachers, such courses as the teaching of arithmetic have formed an important integral part of their professional education. During the past fifty years the emphasis in this course has shifted back and forth between the methods of teaching and the subject matter of arithmetic. At the present time, the emphasis seems to be upon method growing out of subject matter, and these courses are now being called the professional treatment of subject matter in arithmetic. The professional training of elementary teachers has been more highly defined and more objectively pursued than has the training of secondary teachers. While interest in the field of training of secondary teachers has lagged lately there has been an increasing interest in the professionalization of the work. Teachers colleges with curricula designed for the education of secondary teachers, have increased manifoldly in the past twenty-five years. Some of these have curricula patterned after the normal schools, from which they developed, and others have curricula patterned after the liberal arts colleges. Probably the better agencies for training secondary teachers have embodied the strong features of both the professional schools and the liberal arts colleges. In an attempt to prepare teachers of secondary mathematics who had already mastered a body of subject matter, such professional courses as the *teaching of mathematics*, the *teaching of algebra*, etc., were introduced into the colleges. These courses in general have been continued in departments of education which often are in no way connected with the departments of mathematics. In many schools there continues to be open strife between departments of education and subject-matter departments; the one contending that mere knowledge of subject matter does not insure teaching ability, and the other contending that the possession of a body of educational doctrine in no way qualifies one to teach subject matter about which he knows little or nothing. The professional mathematics courses should bridge the gap between educational theory and subject matter. They may contain little or much actual subject matter, depending upon the instructor and the group receiving instruction. During the past decade, several textbooks and theses dealing with the professional treatment of subject matter in several branches of high-school mathematics have appeared in print. These have been stimulating discussion and appraisal which no doubt will lead to a better definition of the

content and technique of professional mathematics courses. Several of these professional treatments of the subject matter of secondary mathematics have been listed in the bibliography.

Table 28 lists the numbers and the per cents of junior high school and senior high school teachers of mathematics who have studied various mathematics courses. This list does not include the general methods courses which are designed to give methods of teaching that are useful in many or all of the separate subjects that the student may teach later. Because many of the junior high school teachers formerly were elementary teachers who were trained in professional schools for teachers, we find that 41 per cent of them have had the course, *the teaching of arithmetic*, while only 15 per cent of the senior high school teachers have had this course. *The teaching of junior high school mathematics* which was studied by 51 per cent of the junior high school teachers and by 16 per cent of the senior high school teachers, includes in some cases material designed primarily for the upper grades of the elementary school. Hence, while it covers much of the subject-matter of the typical three-year junior high school, it does not include all of the material.

For senior hgh school teachers, the *teaching of senior high school mathematics* is the most popular course in professional

TABLE 28

PROFESSIONAL MATHEMATICS COURSES STUDIED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Courses	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
The teaching of Jr. H. S. Math...	136	51	124	16
The teaching of Sr. H. S. Math...	41	15	345	45
The supervision of mathematics .	20	7	90	12
The teaching of algebra.....	52	19	207	27
The teaching of geometry.....	32	12	195	26
The teaching of arithmetic.....	111	41	117	15
Other courses.....	1	0	12	2
No courses given.....	78	29	193	25
Total number of teachers.....	269		763	

mathematics. It has been studied by 45 per cent of the group while the more specialized courses the *teaching of algebra* and the *teaching of geometry* have been studied by 27 per cent and 26 per cent of the teachers, respectively. A small minority of secondary teachers have studied the *teaching of trigonometry.* Table 28 also shows that 29 per cent of the junior high school teachers, and 25 per cent of the senior high school teachers of mathematics have had no course designed particularly for teachers of mathematics. Some of the teachers in these two groups have had a course in *general methods of teaching* which contained some material dealing with the special problems of teaching mathematics. Whether or not courses in professional mathematics are genuinely functional in later teaching depends upon the content, organization, and technique of the course as well as upon the criteria for measuring the work of the teacher. An estimate of the helpfulness of these courses to the teachers concerned has been prepared and is given later in the chapter.

OCCUPATIONAL EXPERIENCE AND TRAINING

In order to determine the routes by which teachers of secondary mathematics have attained the present stage of their careers, a section of the inquiry form was devoted to the items pertaining to the non-teaching work and to the various levels of teaching in which these teachers had participated. The amounts of educational training which they had completed at successive stages as well as the number of semester hours of credit earned while in the present teaching position were also learned. Approximately 30 per cent of both junior and senior high school teachers of mathematics have been engaged in some form of non-teaching work before beginning teaching. About 5 per cent only, of each group, has spent more than five years in some occupation other than teaching. No attempt has been made to determine whether this is desirable. Table 29 shows that 62 per cent of the junior, and 35 per cent of the senior high school teachers have had some experience in an elementary school. In the junior high school group, 34 per cent have had more than five years of elementary teaching, while only 8 per cent of the senior group have a similar amount. In general, junior high school teachers of mathematics have more frequently been recruited from, and have spent a longer time in, elementary teaching than have senior high school teachers.

Because 61 per cent of the junior high school teachers have had five or less years of such teaching experience, this does not mean that they have taught only that many years. It must be remembered that 62 per cent have had elementary teaching ex-

TABLE 29

THE NUMBER OF YEARS THAT TEACHERS OF SECONDARY SCHOOL MATHEMATICS HAVE SPENT IN NON-TEACHING WORK AND IN TEACHING AT VARIOUS LEVELS SINCE HIGH SCHOOL GRADUATION

Occupation	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
Non-teaching work				
0 years	187	70	527	69
1-5	64	24	207	27
more than 5	18	7	39	5
Elementary teaching				
0 years	103	38	497	65
1-5	71	27	211	28
6-10	45	17	35	5
11-15	19	7	15	2
more than 15	27	10	9	1
Jr. H. S. teaching				
0 years			627	82
1-5	162	60	114	15
6-10	74	28	16	2
11-15	25	9	3	0
more than 15	8	3	3	0
Sr. H. S. teaching				
0 years	165	61		
1-5	75	28	202	27
6-10	16	6	214	28
11-15	9	3	142	19
16-20	4	1	92	12
More than 20	0	0	113	15
College teaching				
0 years	265	99	708	93
1-5	4	1	50	7
More than 5	0	0	5	1
Total teachers	269	100	763	100

perience and 28 per cent have had senior high school teaching experience, previously. Obviously, some have had both elementary and senior high school experience. Only 12 per cent of this group have had more than ten years of junior high school teaching experience, which is due no doubt to the relative newness of junior high school organization. Many of the senior high school teachers who have become junior high school teachers had been teaching the same courses before their schools were reorganized.

The material in Table 29 dealing with senior high school teachers' experience, cannot be directly compared with the data in Table 9 of the preceding chapter because the latter is a summary of all teaching experience. According to Table 29, only 18 per cent of the senior high school teachers have had junior high school experience, while 25 per cent of them have had elementary teaching experience. This does not imply that junior high school teachers do not readily become senior high school teachers, because comparatively, there are fewer junior than elementary teachers. It is interesting to note that 8 per cent of the secondary teachers have had college-teaching experience. Most of these people are now located in senior high schools. Of the senior high school teachers, 26 per cent have had more than fifteen years of such experience and 55 per cent have had ten or less years of similar experience.

Related to the occupational experience is the occupational training, which is here defined as the training before beginning teaching plus that which has been gained at various stages in the teacher's career. A small percentage of both groups of teachers began teaching immediately after finishing their elementary school education. These are the older teachers who entered the profession before the significant raising of standards that has been taking place since the turn of the century. All of these teachers began their teaching experience in elementary schools. Only 20 per cent (Table 30) of the junior high school group, and 14 per cent of the senior high school group began their teaching with but four years of education beyond the elementary school. This amount is equivalent to completion of the usual secondary school curriculum. Almost 65 per cent of the senior high school teachers had obtained eight years of education beyond the elementary school before doing any teaching, while less than 30 per cent of the junior high school teachers had attained a similar level.

Approximately one-half of each group of teachers entered their present teaching positions with no additional training than that which they possessed when beginning their first teaching and 15 per cent of each group has had one year of additional training. In the junior high school group, 14 per cent have more than two years of additional training, while in the senior high school group the corresponding per cent is 19.

Table 30 also gives evidence that the majority of each of these two groups of teachers have been extending their education since entering the present position. The junior high school teachers

TABLE 30

THE TRAINING BEYOND ELEMENTARY SCHOOL ACQUIRED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS AT VARIOUS STAGES IN THEIR CAREERS

Stage of career and training	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
Before doing any teaching				
0-years training	7	3	16	2
1-2	3	1	7	1
3-4	44	16	87	11
5-6	95	35	121	16
7-8	110	41	496	65
More than 8	8	3	36	5
Additional training before present position				
0 years training	135	50	401	53
1	44	16	124	16
2	51	19	92	12
3	13	5	36	5
4	18	7	60	8
More than 4	8	3	40	5
While in present position				
0-semester hours	97	36	310	41
1-10	70	26	196	26
11-20	35	13	127	17
21-30	29	11	59	8
More than 30	37	14	59	8
Total number of teachers	269		763	

had the lower level of training when they entered their present position but they also have the larger amount of work completed while in that position. The median number of semester hours for each group is near five, which number approximates the credit usually earned in one summer session.

More than twenty semester hours of credit have been earned by 25 per cent of the junior high school group, while only 16 per cent of the senior high school teachers have the same amount of credit.

If the testimony of many teachers, that the most valuable education they received came after they had several years of actual teaching experience, is reliable, then some adequate provision for the further utilization of this type of training should be insured. The nature of such further study, while still a matter of opinion, should form a challenge for graduate schools offering courses to in-service teachers.

EFFECTIVENESS OF TRAINING

No attempt has been made to determine either the relative or the absolute effectiveness of any of the many factors that have combined to make the individual teacher's training effective for successful and intelligent teaching. No doubt it is not the mere possession of certain personal traits, and elements of training and experience that make for good teaching of secondary mathematics, but rather the way in which these are combined and utilized. Herein is believed to lie the essential difference between the good teacher and the poor teacher. The former, either through natural fitness or through a studied experience approach, has learned not only what to do and when to do a thing, but also how to do it so that the highest type of learning results. The poor teacher may possess similar factors of personal equipment, training, and experience, but lacks the synthesizing and integrating abilities to make the ideal usage of her qualities. On the assumption that teachers are able to determine to some recognizable degree the elements in their training and experience that have contributed most to their success as teachers of mathematics, the teachers in this sample were first asked to rate the degree of helpfulness of certain items and then to give a brief statement telling what they considered the chief contributing factor to their success as a teacher of mathematics. The items which they were asked to rate were obtained by requesting approximately fifty teachers of mathematics to

state the types of courses that they had found most helpful to them as teachers. This same group also listed certain other items considered by them as potent factors in successful teaching. As a part of the inquiry teachers were further requested to list specific courses in educational theory and to check the courses in academic and in professional mathematics that had contributed definitely to their teaching of mathematics. Even though an individual teacher may not be able to evaluate her own experience with absolute reliability, some value should accrue to the cumulative effect of many such evaluations when they tend in the same direction.

Table 31 exhibits a summary of teachers' estimates of the helpfulness of courses in academic college mathematics, in professional mathematics, in educational theory, and in observation and practice-teaching as well as such other factors as an understanding of boys and girls, a natural inclination to teaching, advice from school officers and colleagues, and hard work on the job as these have been variously rated by the teachers. The ratings have been given in three groups, namely, valuable and important, a little value, and no real value. The table also shows how many teachers did not rate each item. In many cases the lack of rating was asserted as due to the non-study of the particular type of course while in other cases teachers apparently did not care to express themselves. Several generalizations from the data are apparent and should be given. Both groups of teachers voted courses in academic college mathematics as valuable and important more frequently than they did courses in professional mathematics. The junior high school teachers more often considered courses in educational theory and in observation and practice-teaching valuable and important than they did either type of mathematics course. By combining the information from Tables 4, 27, and 28 with Table 32, the ratios of the number who rated certain types of courses as valuable and important to the number who had studied such courses may be derived. These ratios show that 729 out of 958, or 76 per cent of both junior and senior high school teachers find courses in academic mathematics valuable and important. Similar ratios and per cents for professional mathematics and educational theory courses are 507 out of 761, or 67 per cent, and 539 out of 980, or 55 per cent respectively. A small group of both junior and senior high school teachers

TABLE 31

THE ESTIMATES GIVEN BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS OF THE HELPFULNESS OF VARIOUS FACTORS OF THEIR TRAINING AND EXPERIENCE

Factors of training and experience and helpfulness	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
Courses in academic mathematics				
valuable and important	151	56	578	77
a little value	46	17	96	13
no real value	11	4	11	1
no information	61	23	69	9
Courses in professional mathematics				
valuable and important	131	49	376	49
a little value	39	14	99	13
no real value	8	3	30	4
no information	91	34	258	34
Courses in educational theory				
valuable and important	167	62	372	49
a little value	58	22	250	33
no real value	11	4	42	5
no information	33	12	99	13
Courses in observation and practice teaching				
valuable and important	153	57	340	45
a little value	43	16	112	15
no real value	7	3	33	4
no information	66	24	278	36
An understanding of boys and girls				
valuable and important	248	92	670	88
a little value	8	3	19	2
no real value	1	0	2	0
no information	12	4	72	9
A natural inclination toward teaching				
valuable and important	233	87	638	84
a little value	13	5	45	6
no real value	3	1	6	1
no information	20	7	74	10

TABLE 31 (*Continued*)

Factors of training and experience and helpfulness	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
Advice of colleagues and school official				
valuable and important	161	60	446	59
a little value	68	25	179	23
no real value	12	4	42	5
no information	28	10	96	13
My own hard work on the job				
valuable and important	243	90	683	89
a little value	6	2	15	2
no real value	0	0	4	1
no information	20	7	61	8
Number of teachers concerned	269	100	763	100

stated that the advanced academic mathematics courses were not directly useful to them as secondary mathematics teachers and that the professors seemed more interested in merely teaching more mathematics than they were in helping teachers. When it is recalled that most of the students in the graduate schools of mathematics are either teachers or potential teachers this minority charge against the college professors is worth noting.

Apparently teachers of secondary mathematics consider that an understanding of boys and girls, and their own hard work on the job are often of significant value in their helpfulness. It is interesting to note that approximately 85 per cent of each group of teachers feels the importance of a natural inclination to teaching. This again raises the issue concerning the actuality of the natural teacher and the non-adaptability of the non-natural teacher. It is also an interesting observation that the advice of colleagues and school officers is not always appreciated or found important in its helpfulness to teachers of mathematics. Table 31 does not reveal some minority expressions that appeared in the original data. On the inquiry sheets, a minority of teachers took occasion to write briefly concerning the value of certain items mentioned. These may be summarized in one composite statement as fol-

lows, "All the mathematics courses were valuable, the educational theory was of no value and neither was the advice of school officials." It must be remembered that although this group represents a distinct minority, nevertheless the feelings expressed were apparently strong and sincere. The expression concerning educational theory was more common than those relating to school officials and academic mathematics.

The testimony of a considerable number of these teachers tends to show that the effectiveness of each of these factors depends upon the individual and upon a majority of the other intrinsic and extrinsic factors involved. Likewise, it is the combination of many factors that has made their teaching successful. Therefore, what is needed is the discovery of a proper balance between academic, professional, and apprentice-training as well as an exposition and cultivation of the necessary personal factors combined with an assurance that the balance can and must be achieved.

In one section of the inquiry form, teachers were requested to underline those academic and professional mathematics courses that were definitely helpful to them as teachers. In still another section, they were asked to rate the general effectiveness of these two types of courses in respect to their contributions to the teaching of secondary mathematics. More teachers rated the group as a whole, than underlined individual courses. This was interpreted to signify that the direction to so underline courses was not adequately presented in the form, and that underlining was too great a task for some teachers. Then too, as some teachers definitely stated, the value of the courses came from the combination of them rather than from the specific courses studied. All of this information in terms of the number of teachers who studied a course, with the number and the per cent of those who voted the course definitely helpful, has been presented in Table 32. The last item in each of the lists of courses includes the total number of teachers who have studied this type of course and the number and per cent of those who stated that this study was valuable or important to them. It is worthy of mention that 81 per cent of the senior, and 62 per cent of the junior high school teachers who have studied some academic college mathematics, attach more than a little value and importance to this study. In general, those separate academic courses that come early in the college

TABLE 32

THE HELPFULNESS OF CERTAIN ACADEMIC AND PROFESSIONAL MATHEMATICS COURSES AS RATED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Helpful courses	Jr. H. S. teachers			Sr. H. S. teachers		
	Number studied	Number helped	Per cent helped	Number studied	Number helped	Per cent helped
ACADEMIC COURSES						
General mathematics	76	30	40	112	45	40
College algebra	164	62	38	602	323	54
Trigonometry	152	37	24	603	275	46
Plane analytic geometry	117	31	27	612	221	36
Calculus	75	7	9	555	108	19
Theory of equations	28	9	32	250	86	34
Theory of numbers	14	3	21	73	11	15
Modern geometry	17	3	18	146	35	24
History of mathematics	42	18	43	229	82	36
Mathematical statistics	30	6	20	137	18	13
Mathematics of finance	19	5	26	81	14	17
College physics	92	14	15	419	121	29
General, no special courses	243	151	62	725	587	81
PROFESSIONAL COURSES						
The teaching of Jr. H.S. mathematics	136	83	61	124	61	49
The teaching of Sr. H.S. mathematics	41	21	51	345	197	57
The teaching of algebra	52	36	69	207	124	59
The teaching of geometry	32	21	66	195	111	57
The teaching of arithmetic	111	51	46	117	54	46
General, no special courses	191	131	70	570	376	66
Total number of teachers	269			763		

career and have a close relation to high school mathematics are more frequently voted as definitely helpful by teachers who have studied them, than are the more advanced courses. *History of mathematics*, *theory of equations*, and *college physics* are among the courses that received a relatively high percentage of ratings as helpful. One course that was separately listed and voted as definitely helpful by a small group of teachers, was *college geometry*. This course is not given in many of our colleges and hence a large percentage of the teachers have not had the opportunity to study it. However, special significance has been attached to this course by the senior high school teachers who have studied it, because as some pointed out, it is the only academic college mathematics course that is closely related to the Euclidean geometry that these teachers are often required to teach.

It is interesting to note that fewer teachers have studied the professional than the academic mathematics courses, but that the percentages of those who have found the former definitely helpful are higher. There is much relative agreement in the percentages of those who have found various professional courses helpful, with the highest percentage for the *teaching of algebra* and the lowest for the *teaching of arithmetic*, in both the junior and senior high school groups. As has been previously pointed out, not only the content but also the organization and technique of these courses have been inadequately defined. Because they differ so, one can not generalize as to the particular value of the courses other than to observe that apparently they are considered relatively valuable by both junior and senior high school teachers of mathematics.

The teachers were not asked to list separately the different courses which they had studied in the field of educational theory. When this was attempted with a trial group, it was found upon investigation that courses with different titles overlapped so much in content, and that so many apparently similar if not identical courses had been studied by some teachers, that no real significance could be attached to such a list of separate courses. Even the number of semester hours of study in this field, as in other fields for that matter, is no real indication of the amount of learning, or of the possible benefit to be derived from this study. To illustrate: one teacher of mathematics has studied *general psychology*, *educational psychology*, *experimental educational psy-*

chology, another course in *educational psychology,* and *specialized psychology* as well as the closely related courses of *introduction to education, technique of teaching,* and *principles of education.* All of these courses have been allowed credit in standard undergraduate and graduate educational institutions to the sum of twenty-one semester hours, and by this teacher's testimony the amount of duplication and denial of material from one course to another is so great that when all the controversial matter has been removed, the resulting body of related materials could probably be learned in one course receiving not over five semester hours of credit. Perhaps this illustrative example is an extreme one, yet it is not uncommon. It illustrates a situation that has developed within the country during the decades that have witnessed a tremendous growth in the size, number, and influence, of departments and schools of education. The current situation in the field of educational theory is faintly reminiscent of the philosophical discussions of the Middle Ages in that neither succeeded in limiting and classifying its assumptions and the arguments that developed from these assumptions. However, there is much testimony that the workers in the field of educational theory are now busily engaged not only in examining and testing their assumptions, but also in building a science of education by the employment of what they describe as the scientific method in education.

If the educational theory is to be of most service to teachers of mathematics, it should eliminate much of the overlapping that now exists and thereby release time and opportunity for further study within this field or in other fields. It should be possible too, to define the contributions of each of these courses to a teacher's equipment. One such attempt has recently been made in the publication of the yearbook of the National Society of College Teachers of Education devoted to "The Direct Contribution of Educational Psychology to Teacher Training."[1] It must be remembered that educational theory is not a usual field of study in the secondary school and hence it is valuable to a secondary teacher only as it contributes to the teaching of some other branch of knowledge. Until educational theory becomes one of the bodies of essential knowledge that is useful in interpreting the

[1]The Direct Contribution of Educational Psychology to Teacher Training. Published in the Year Book of the National Society of College Teachers of Education. 1932.

civilization in which we find ourselves, it will probably not enter the secondary field as a body of knowledge to be studied on that level. That educational theory has had a great influence in the professionalization of secondary teaching cannot be denied. It has been considered of such great importance by the various state departments of education that every state now has a regulation requiring that each teacher who is now certified within the state, shall have studied educational theory. As is shown in chapter five, this is the only certification requirement common to all states.

As a means of obtaining some indication of the relative frequency with which teachers of secondary mathematics have found courses in educational theory valuable, they were asked to list on the inquiry form any courses in that field that had been definitely helpful to them as teachers of mathematics. These responses are summarized in Table 33 which gives the courses that were listed, classified under eight heads, and also gives the number of teachers who listed none as definitely helpful. No doubt some of those who listed none merely found it easier to leave the space blank, yet many of those same teachers found it convenient to

TABLE 33

THE COURSES IN EDUCATIONAL THEORY THAT WERE LISTED AS HELPFUL BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Helpful courses	Number of teachers listing courses		
	Jr. H.S.	Sr. H. S.	Total
Psychology	95	227	322
Principles of education	35	104	139
Methods of teaching	42	68	110
Practice-teaching	7	15	22
History of education	4	14	18
Measurements and statistics	37	91	128
School administraton	5	9	14
Other courses	18	58	76
None	138	433	571
Number of teachers who have studied educational theory	260	731	991
Total number of teachers	269	763	1032

give other information. Although 96 per cent of these teachers have studied in the field of educational theory, it is not known how many have studied each of the eight divisions listed in Table 33.

Only the frequencies for the junior high school group, for the senior high school group, and for the combined groups have been included, and no percentages were determined because no fair or adequate base was available. While courses in psychology were most often listed and courses in administration least often, no real significance can be attached to these frequencies for the obvious reason that the one was studied by many more teachers than the other. Practice-teaching was listed by a comparatively small number of teachers. One reason for this is that observation and practice-teaching are often considered as a separate body of work to be accomplished, and are not classified as courses to be studied. Several teachers commented upon the distinct helpfulness of their work in practice-teaching and in the observation of a skillful teacher or supervisor, who in many cases was named. Likewise, a considerable group although a distinct minority, stated that all courses taken under certain named teachers were helpful to them. The teachers so named are all nationally-known educators connected with leading graduate schools of education. Here is an implication that the value of the course depends not alone upon the content but probably more upon the personality of the instructor. That in itself should be a challenge to graduate professors of education. A total of 571 or about 57 per cent of all those who had studied some educational theory did not list any such courses as definitely helpful to them. The reasons for not having listed such courses are not known.

Finally, in an attempt to learn what teachers themselves considered the chief contributing factor to their success as teachers, they were asked to state this briefly. Many of the responses were repetitions of the items already listed in Table 31, so no summary of them all has been made. On the other hand, many of the statements were so meaningful and sincere that a representative number showing different emphases were considered of sufficient value to be quoted here. An analysis of these replies gives some insight into the consciousness with which the teacher attacks the job of teaching secondary mathematics. The statements follow.

"I feel that I have made great advances as a teacher whenever I have met a superior who had the interest and tact to give me

the desire and opportunity to improve my work. In addition, I prefer teaching to any other job I know."

"Practice in making complex ideas simple; in getting at basic principles; sense of humor."

"Willingness to work hard."

"The knowledge of mathematics gained in college; the excellent example of clear, forceful presentation given by the mathematics professors there."

"A New England conscience; a love of work and association with high-grade teachers in a school of fine standards furnished both the inspiration and the ability to attain."

"The inspiration through geometry. It is almost a religion with me to inspire the youth under my instruction to admire, desire, and acquire COMMON SENSE, for which geometry is par excellence."

"Insistence upon accuracy; thoroughness; repetition; frequent drill."

"Aside from personal characteristics, my preparation, which has given me confidence in my position. Had I had practice-teaching before I began, I feel that my success would have been attained earlier than it was."

"Common sense, industry, avoiding all prejudice, good judgment, Christian principles, backed by thorough academic knowledge of the subject."

"Observation and practice-teaching courses helped me as much as the other courses in college. Four visiting days during the past four years have helped also."

"By trying to accomplish what I consider worthwhile things in mathematics—principally to develop reasoning, and as a basic course for higher mathematics, with some appreciation of the art side of it."

"I enjoy it."

"Natural inclination to the subject; adherence to the main object of education, viz:—help the student to help himself, which can be accomplished only by logical thinking."

"When I began my teaching, my principal (to whom I had previously gone to school) helped me immeasurably."

"I believe the fact that I had a complete major, methods, and practice-teaching in mathematics before attempting to teach it, was chiefly responsible for success."

"A great natural."

"Ability to tell the difference between mere formality and actual results, plus enough initiative to try new methods where old ones fail."

"Good school to teach in, good equipment, and good preparation."

"A successful teacher must be alert to grow. Creative ability in teaching must be associated with splendid academic training and professional study. That means hard work, of course. Any teacher must like boys and girls, however a mere understanding of pupils does not make a good mathematics teacher."

"Since I have taught such a short time, I can hardly say as to my success. Practice-teaching and hard work, including encouragement, have helped me very much."

"My elementary, high school, and a few college, teachers. High school teachers were highly trained men of mature years, with mental and moral poise."

"My thorough German training (abroad), love of work and children. I regard teaching as a profession, not as a job, and I chose it as my life work."

TEACHING AND STUDYING MATHEMATICS

The channels through which teachers of secondary mathematics attained their present positions have been described and summarized in Table 29. It was also thought desirable, if possible, to determine the most important forces influencing these people to become teachers of mathematics. This was done by asking them to check certain reasons that had been offered by a trial group of teachers. These reasons are classified in Table 34 with the frequencies for each person adjoined. In some cases, two reasons were checked as important and both of these have been tabulated. Hence the per cents are figured on the total number of checks and not on the total number of teachers. It is gratifying that a majority of the teachers, approximately two-thirds in each of the junior and the senior high school groups, have liked the subject and wished to teach it. However, 26 per cent of the junior and 13 per cent of the senior high school teachers were requested or required to teach the subject. This group is composed of two different types of teacher, those who were required to teach mathematics when they did not wish to do so, and those who were requested and were agreeable to the request. Unfortunately, the inquiry form was not explicit in separating these two types. A minority

expression from these teachers who entered the field of mathematics through chance or request, indicates that they have remained in the work because they liked it and were fascinated by further acquaintance with mathematics. Another group indicated that an apparent liking for the field was probably conditioned by the influence of a good teacher.

In many phases of this inquiry, tributes have been written to the influence of some excellent teachers whose identities often remain unknown. These are found among both high school and college teachers. The qualities of these teachers are much greater than mere likeable personalities; they encompass breadth of understanding, depth of scholarship, and a consciousness of the value of doing one's work well. To college teachers of mathematics, of educational theory, and of other branches of learning that enter into a teacher's training, this should be a challenge of great importance. To the officials who direct the colleges and graduate schools that are supplying teachers of mathematics for our secondary schools, these tributes should reaffirm their responsibility that real teachers are not only employed, but are also allowed and encouraged to be masters in their field and to excel as teachers.

Because certain groups, such as the college academicians, have been charging that the teachers of secondary mathematics have received an inadequate academic background in the field, it was deemed of potential value to seek reasons given by teachers for not having studied more academic college mathematics. These reasons together with the frequencies with which junior and senior high school teachers checked them and the per cents of the total number of persons checked by both groups of teachers appear in Table 35. Since several teachers checked more than one reason for not having studied more academic college mathematics, the total number of checks exceed the total number of teachers in each of the junior and senior high school groups. These total frequencies are used as bases for computing the per cents. From the table, it appears that 28 per cent of the junior, and 41 per cent of the senior high school teachers state that they took all the mathematics that was offered or was possible because of other restrictions imposed by the college. If these are teachers who have small amounts of study in this field, they then were merely the victims of a situation beyond their control after they entered the

TABLE 34

THE REASONS AND INFLUENCES CITED BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS FOR BECOMING TEACHERS OF THIS SUBJECT

Reasons for becoming a teacher of mathematics	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
Influence of a high school teacher	4	1	23	3
Influence of a college teacher	8	3	37	5
Liked the subject and wished to teach it	175	64	540	70
Chance or accident	17	6	64	8
Requested or required	73	26	103	13
Total reasons including cases where more than one was given	277	100	767	100
No reason given	1		10	
Total number of teachers	269		763	

TABLE 35

THE REASONS GIVEN BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS FOR NOT HAVING STUDIED MORE ACADEMIC COLLEGE MATHEMATICS

Reasons for not studying more mathematics	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
Took all that was offered or was possible in the course	81	28	301	41
Took as much as was required	66	23	114	15
Did not like the teachers of mathematics	4	1	9	1
Never expected to teach mathematics	93	32	145	20
Did not like mathematics	4	1	9	1
Took a well-rounded program	42	14	166	22
Total reasons including cases where more than one was given	290	100	744	100
No reasons given	2		26	
Total number of teachers	269		763	

particular college, hence the college, not the teacher, should be blamed for an insufficient ability to educate teachers of mathematics. Relatively large groups of both junior and senior high school teachers did not expect to teach mathematics when they were students in college, and for that acceptable reason did not study as much mathematics as was possible or desirable. Only 2 per cent of each group testified that they did not like mathematics or the teachers of mathematics in college. A large number of teachers studied as many courses as were required for college graduation, and another considerable group took as much as was possible without distorting their programs from that of a well-rounded education. Better articulation between the certifying bodies, the agencies of training, and the employing agencies, should make it easily possible to insure adequate academic preparation for teachers of secondary mathematics.

WHY TEACH ALGEBRA AND GEOMETRY

There are conflicting ideas concerning the reasons for including the study of *algebra* and *geometry* in the secondary school curriculum. Even among the teachers of mathematics there is much discussion concerning the benefits to be derived from the study of *Euclidean plane geometry*. This subject appears as one of the required courses in the majority of the high schools, and it is also required for entrance to most of the standard colleges. The benefits derived from the study of *demonstrative geometry* were at one time associated with a type of educational psychology that held rigorously to the transfer values of logical thinking supposed to be engendered by *geometry*. Among teachers of mathematics, discussions concerning desirable methods of teaching usually result in a further discussion of the reasons for, and values in learning geometry, with a growing belief that there is some lower limit of intelligence below which the pupils cannot profit sufficiently to warrant the expenditure of time requisite for a mastery of the elements of the course. With apparent disagreement among mathematics teachers and with constant attack from without, the place of mathematics in the secondary school curriculum has been threatened.

Because *elementary algebra* and *plane geometry* appear most frequently in the secondary school curriculum, three reasons for teaching *elementary algebra* and four for teaching *plane geometry*

were listed in the inquiry form so that teachers might indicate a preference. There were many who checked more than one reason, but others did not check any. Some of these latter said that they were not teaching the course and did not feel that they should express themselves concerning it. The summary of responses is given in Table 36, which gives the frequencies of the different reasons for teaching these courses, and the per cents of the total number of reasons given. There is much similarity between the percentages in the columns of junior and of senior high school teachers. This evidence tends to show that teachers consider

TABLE 36

SOME MAIN REASONS FOR TEACHING ELEMENTARY ALGEBRA AND PLANE GEOMETRY AS GIVEN BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Course and reason	Jr. H. S. teachers		Sr. H. S. teachers	
	Number	Per cent	Number	Per cent
ELEMENTARY ALGEBRA (usually 9th grade)				
Trains pupils to think abstractly with symbols	111	35	468	39
Necessary for a further study of mathematics	143	45	505	42
Directly useful in the life about us	66	21	238	20
Total number of reasons	320	100	1211	100
No reason given	84		68	
PLANE GEOMETRY (usually 10th grade)				
Trains pupils to think logically in life situations	66	22	396	25
Acquaints pupils with geometric figures in our surroundings	83	27	379	24
Gives pupils valuable practice in deductive thinking	94	31	492	31
Needed for entrance to most colleges	63	21	345	21
Total number of reasons	306	100	1612	100
No reasons given	128		76	
Total number of teachers	269		763	

neither *elementary algebra* nor *plane geometry* of most value in their direct application to ordinary living. Because of the rather marked lack of rating any one reason significantly higher than another, we may conclude that teachers are still puzzled over the main purpose in teaching these courses, or perhaps the better explanation is, that the teachers genuinely feel that all of the reasons given are valid. In fact, all of the listed reasons had been previously named by mathematics teachers, and this inquiry merely corroborates the statement that the contribution of secondary mathematics to the education of a secondary school pupil is more general than it is definitely specific. Admittedly, the reasons listed were not of such widely different types that a marked disparity of opinion could be drawn. However, both groups of mathematics teachers tend to consider that *elementary algebra* is taught primarily because it is necessary for a further study of mathematics and because it trains pupils to think abstractly with symbols, and secondly, because it is directly useful in the life about us. *Geometry*, according to this same body of opinion, is taught because it gives valuable practice in deductive thinking, trains pupils to think logically in life situations, acquaints pupils with geometric figures in our surroundings, and is necessary for college entrance. Because of the similarity of votes for all of the reasons, it seems wise to suggest that a further consideration of the values to be derived from a study of *geometry* in the secondary school should be made together with an examination of the methods of teaching and learning that will insure the attainment of the objectives set up. Obviously, some of the values claimed by teachers for *geometry*, are dependent upon and germane to the methods of teaching and learning employed.

The professional interest of these teachers was indicated by the professional magazines which they listed as read by them. These were divided into two classes, the mathematical and the general. More than one-half of the junior high school teachers do not read any professional-mathematical magazine regularly. Most of those who do read one, choose the *Mathematics Teacher*, which is also the magazine most frequently read by senior high school teachers. Among this latter group, a considerable minority read *School Science and Mathematics* which is published in the mid-western part of the country and read principally by teachers in that section. In the field of general-professional magazines,

approximate groups read the state journal and the Journal of the National Education Association. In the junior high school group of 269 teachers, 157, or 63 per cent do not read any professional-mathematical magazine regularly, and 80, or 30 per cent, do not read any general-professional magazine regularly. For the senior high school group the corresponding figures and per cents are 328, or 43 per cent, and 245 teachers or 32 per cent, respectively. One can only speculate as to the methods employed by these large groups of teachers to keep abreast of the changes taking place in education in this country. Perhaps the professional atmosphere and educational leadership in their schools is not conducive to further study and reading of a professional nature.

COURSES TAUGHT

An inspection of the teaching schedules of these junior and senior high school teachers of mathematics shows that the majority of them teach only mathematics and that a minority teach mathematics combined with some other subjects. As has previously been shown, these combinations are most often with some form of physical science. The present sample did not include many who teach mathematics as a minor interest and some other subject as a major interest. However an inspection of the training records of these teachers shows that in general they have the same amount of educational training as do the teachers who teach mathematics mainly or entirely, but their mathematical training is less than the average for the entire group. It is not as low however as that of the lowest 10 per cent of the whole group. From the data of this study it appears that the weakness of mathematical training in the secondary teaching population is not so much a concern of, or problem with, the teachers who have specialized in some other subject which they teach principally while they teach one or two courses in mathematics, as it is with the teachers who teach mathematics mainly and are insufficiently prepared in respect to their academic training. A closer inspection of these training records reveals that a goodly group of both junior and senior high school teachers have apparently studied educational theory as their major interest in college. If educational theory is not a proper and sufficient academic background for a teacher of mathematics in a secondary school it should be made impossible for school officials to engage teachers who have

such preparation. If, on the other hand, these teachers have developed an educational zeal and an inspiring personality so that later they independently master the extensions of mathematical subject matter which are genuinely requisite for an intelligent teaching of secondary mathematics, then large amounts of educational theory may be desirable. However, as has already been pointed out, the testimony of a large group of teachers tends to oppose the idea that large amounts of educational theory are proportionately valuable in successful and intelligent teaching of mathematics.

In Table 37 a compilation is given of the total frequencies of the mathematics courses usually taught in secondary schools by these 269 junior, and 763 senior high school teachers. The per cents in the table are computed on the total frequencies of all the courses taught. Because a large percentage of the junior high schools do not offer courses in particular mathematical subjects,

TABLE 37

THE PROFESSIONAL MAGAZINES THAT ARE READ REGULARLY BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Professional magazine	Number of teachers who read magazine		
	Junior high school	Senior high school	Both
MATHEMATICAL MAGAZINES			
The Mathematics Teacher	99	320	419
School Science and Mathematics	19	133	152
Some other magazine	4	36	40
None listed	157	328	485
GENERAL PROFESSIONAL MAGAZINES			
The local state journal of education	93	212	305
The Journal of the National Education Association	97	229	326
Some other educational magazine or periodical	109	247	356
None listed	80	245	325
Total number of teachers	269	763	1032

such as *algebra* and *geometry*, but offer instead a general type commonly referred to by the name of the grade in which it is taught, e.g.,—*8th grade mathematics*—the junior high school work has been given by grades. In a minority of cases, *elementary algebra* and *arithmetic* were listed separately. In the table, *elementary algebra* has been listed with the ninth grade course because the usual material of this grade is most often similar to that in *elementary algebra*.

It is apparent that the junior high school teachers often divide their time between mathematics and some other field of instruction. This is particularly true of teachers in smaller cities. In the larger cities, the work is usually departmentalized so that a teacher instructs in one field, principally. Although the desirability of strict departmentalization in the junior high school is still a matter of debate, its continuance seems at least temporarily assured.

In the senior high school, departmentalization is more highly defined and more rigorously pursued than in the junior high school. From the list of courses taught, several interesting observations may be made. These would be more suggestive if similar information for a few decades ago existed, so that trends could more readily be shown. Apparently the most common mathematics course taught in the senior high school is *plane geometry*, which fact is undoubtedly due to the present organization of these schools. *Elementary algebra* is the customary mathematics course of the ninth grade, which in some school organizations appears in the junior high school, and in others in the senior high school. According to Table 37, *solid geometry*, *advanced algebra*, and *trigonometry* are courses of minor teaching frequency, with *solid geometry* slightly more frequent than the others. The remaining mathematics courses constitute 3 per cent of the total and includes such courses as *the slide rule*, *analytic geometry*, *calculus*, and occasionally some other advanced course that is generally given in the typical college curriculum. The courses and their frequencies as found in the table are suggestive not only of the teaching that is being done, but also of the mathematical training necessary for intelligent teaching of these courses.

The average number of classes taught per day by junior high school teachers is almost six, and by senior high school teachers approximately five. These classes range widely in size, with a

central tendency between thirty and forty pupils. In small schools the classes are often quite small, ranging down to less than ten pupils per class. In a few of the larger cities most of the teachers have classes varying between forty and fifty pupils. These classes recite five days per week, for an average of approximately forty minutes per day in the junior high school, and forty-five minutes per day in the senior high school.

An inspection of the training records of those who teach only *algebra*, or only *geometry*, does not reveal that these are significantly different from those who teach not one, but several courses. A very small minority of teachers devote all of their instructional time to several sections of the same course, and these as might be expected are not widely distributed, but are found in a few systems where several or all of the teachers serve as course specialists. Apparently this assignment of courses has been made upon the basis of teacher's choice or some other such basis, and not upon

TABLE 38

THE TOTAL FREQUENCIES OF VARIOUS COURSES TAUGHT BY TEACHERS OF SECONDARY SCHOOL MATHEMATICS

Course taught	Number of classes taught by teachers			
	Junior high school	Per cent of total	Senior high school	Per cent of total
Seventh grade mathematics	404	26		
Eighth grade mathematics	356	23		
Ninth grade mathematics (including elementary algebra)	286	18		
Arithmetic	42	3	245	6
Elementary algebra			961	25
Intermediate algebra			331	9
Advanced algebra			134	4
Plane geometry			1013	27
Solid geometry			207	5
Trigonometry			127	3
Other mathematics courses	5	0	110	3
Other non-mathematics courses	470	30	670	18
All courses taught	1563	100	3798	100
All teachers	269		763	

a specific preparation for one relatively narrow specialty. The educational expediency and the desirability of such specialization in teaching may be questioned.

EXTENDED TRAINING

Practically one-half of these teachers of mathematics have done some studying to advance their level of training after entering the teaching profession and before undertaking the present position. Approximately 60 per cent have done some such studying since they entered the present teaching position. These two groups overlap considerably and are in no way mutually exclusive. On the assumption that academic college mathematics and educational theory are two fields of study in which these teachers are probably extending their education, a tabulation has been made of the amounts of credit earned in these two fields by teachers who have done varying amounts of study since beginning teaching. There is no absolute proof that this extended study was in the fields indicated, however there is a high probability that such is the case. Tables 39 and 40 have been prepared to show the number of junior and senior high school teachers of mathematics who have achieved varying amounts of training and study since beginning teaching, and also the amounts of credit in academic mathematics and in educational theory earned by these teachers. In a few cases the information was incomplete, therefore the total frequencies do not include all of the teachers. The total omissions for both junior and senior high school groups is not over two per cent. In order to show the significance of this data more adequately, Figures IV and V have been derived from Tables 39 and 40.

Figure IV shows that the senior high school teachers of mathematics who have acquired no further training during the interval between the first teaching position and the present one form a relatively large percentage of those who have small amounts of credit in educational theory, and a small percentage of those who have large amounts of credit in this field. While this group constitutes more than 50 per cent of all the senior high school teachers of mathematics, they are only 36 per cent of the group having 31-40 semester hours of credit in educational theory, and 22 per cent of the group having 40 or more semester hours of credit in that field. On the other hand, Figure IV shows that both the

TABLE 39

THE RELATION OF THE NUMBER OF SEMESTER HOURS OF CREDIT IN EDUCATIONAL THEORY TO THE AMOUNT OF TRAINING ACQUIRED AFTER BEGINNING TEACHING

Training	Semester hours of credit in educational theory								
	0	1-6	7-12	13-18	19-24	25-30	31-40	More than 40	Total
After beginning but before present position									
0 years									
Jr.H.S.	5	10	21	35	30	14	10	6	131
Sr.H.S.	20	35	60	98	91	49	31	15	399
1 year									
Jr.H.S.	1	3	7	10	11	7	5	0	44
Sr.H.S.	1	4	14	25	23	21	17	19	124
2 years									
Jr.H.S.	1	4	10	10	9	7	5	5	51
Sr.H.S.	2	4	11	15	11	16	21	12	92
3 years									
Jr.H.S.	0	1	3	3	2	1	1	1	12
Sr.H.S.	1	2	6	7	5	4	5	5	35
4 years									
Jr.H.S.	0	0	4	1	2	5	4	2	18
Sr.H.S.	2	2	5	9	17	8	10	7	60
5 years or more Jr.H.S.	0	2	2	0	0	1	1	1	7
Sr.H.S.	1	2	5	4	5	9	2	10	38
Totals Jr.H.S.	7	20	47	59	54	35	26	15	265
Sr.H.S.	27	49	101	158	152	107	86	68	748
Since entering present position									
0 Sem. Hrs.									
Jr.H.S.	3	7	15	26	22	13	5	3	94
Sr.H.S.	22	26	53	63	61	38	19	26	308
1-10 Sem. Hrs.									
Jr.H.S.	3	7	10	15	14	8	11	2	70
Sr.H.S.	3	13	23	49	41	27	24	12	192
11-20 Sem. Hrs.									
Jr.H.S.	1	4	8	8	3	5	3	2	34
Sr.H.S.	1	6	22	20	23	22	20	9	123

TABLE 39 (*Continued*)

Training	Semester hours of credit in educational theory								
	0	1-6	7-12	13-18	19-24	25-30	31-40	More than 40	Total
Since entering present position									
21-30 Sem. Hrs.									
Jr.H.S.	0	1	5	6	7	4	2	4	29
Sr.H.S.	0	1	4	7	11	12	14	11	60
31 Sem. Hrs. or more Jr.H.S.	0	1	8	5	7	7	5	4	37
Sr.H.S.	1	3	6	12	12	7	10	11	62
Totals Jr.H.S.	7	20	46	60	53	37	26	15	264
Sr.H.S.	27	49	108	151	148	106	87	69	745

group having one or two years of training since their first teaching position and the group having three or more years of such training form relatively large per cents of those groups having large amounts of credit in educational theory, and small per cents of those having but little credit in that field. Figure IV also shows the same trend for those teachers who have extended their education while in the present teaching position. While these are tendencies that should be expected, their significance lies in their extent. A similar figure (Figure V) was prepared, to determine whether the same tendencies apply to academic college mathematics, and whether to a greater or lesser degree than was apparent in educational theory. Figure V shows that those senior high school teachers who have not extended their training between their first and their present teaching position, compose larger per cents of the groups having small amounts of credit in academic college mathematics, and smaller per cents of those having larger amounts of credit in this field. However, the tendency is not very marked, and especially is this true when compared to the similar trend in the field of educational theory. Conversely, there is a slight inclination toward larger per cents of those groups having larger amounts of credit in academic college mathematics for teachers who have extended their training during the period designated. Those teachers who have been adding to their training since en-

TABLE 40

THE RELATION OF THE AMOUNT OF CREDIT EARNED IN ACADEMIC COLLEGE MATHEMATICS TO THE AMOUNT OF TRAINING ACQUIRED AFTER BEGINNING TEACHING

Training	Semester hours of credit in mathematics							
	0	1-10	11-20	21-30	31-40	41-50	More than 50	Total
After beginning but before present position								
0 years								
Jr.H.S.	18	54	33	17	8	0	1	131
Sr.H.S.	12	46	127	116	61	19	16	397
1 year								
Jr.H.S.	4	16	14	6	4	0	0	44
Sr.H.S.	3	14	27	28	27	12	9	120
2 years								
Jr.H.S.	7	19	15	6	3	1	0	51
Sr.H.S.	3	14	26	24	19	4	1	91
3 years								
Jr.H.S.	1	5	5	1	0	0	0	12
Sr.H.S.	0	4	10	11	6	3	1	35
4 years								
Jr.H.S.	3	6	5	4	0	0	0	18
Sr.H.S.	2	9	25	16	4	2	2	60
5 years or more Jr.H.S.	1	2	2	1	0	0	1	7
Sr. H.S.	1	2	16	7	6	2	4	38
Totals Jr.H.S.	34	102	74	35	15	1	2	263
Sr.H.S.	21	89	231	202	123	42	23	741
Since entering present position								
0 Sem. Hrs.								
Jr.H.S.	12	38	27	13	5	0	1	96
Sr.H.S.	14	40	93	88	43	18	12	308
1-10 Sem. Hrs.								
Jr.H.S.	9	25	21	9	5	1	0	70
Sr.H.S.	2	21	71	51	36	8	3	192
11-20 Sem. Hrs.								
Jr.H.S.	6	12	8	6	2	0	0	34
Sr.H.S.	2	13	39	34	25	9	4	126

TABLE 40 (*Continued*)

Training	Semester hours of credit in mathematics							
	0	1-10	11-20	21-30	31-40	41-50	More than 50	Total
Since entering present position 21-30 Sem. Hrs. Jr.H.S.....	4	10	9	4	1	0	1	29
Sr.H.S.....	2	2	13	19	14	6	5	61
31 Sem. Hrs. or more Jr.H.S.....	4	16	13	2	2	0	0	37
Sr.H.S.....	1	15	13	16	9	2	4	60
Totals Jr.H.S.....	35	101	78	34	15	1	2	266
Sr.H.S.....	21	91	229	208	127	43	28	747

tering the present position, form a noticeably greater per cent of those groups of teachers who have some credit in academic college mathematics, than they do of the group that has no such credit. This group, however, does not form a significantly large per cent of those who have large amounts of credit in academic college mathematics.

In viewing Figures IV and V together, a generalization is apparent. Those teachers who have extended their training since beginning teaching form larger percentages of those groups having relatively large amounts of credit in the fields of educational theory and academic college mathematics than they do of the groups that have relatively small amounts of credit in these fields. Also and of greater significance, these tendencies are very marked in respect to educational theory and only slightly noted in the field of academic college mathematics. This leads to the conclusion that the teachers who are extending their education are doing so in the field of educational theory rather than in the field of mathematics. Although the reason for this was not sought a small group of teachers expressed themselves apologetically by saying that degrees were easier to get in educational theory than in academic mathematics. Other teachers stated that the advanced courses in mathematics and the way in which they were taught did not help them as secondary school teachers. Another minority

expression mentioned the greater value of educational theory studied after having taught than before teaching. The nature of the training that teachers should seek after having taught should depend not only upon their own backgrounds but also upon an investigation of the relative values of different types and programs of studies as well as the methods of teaching them.

Figures VI and VII give the same information concerning junior high school teachers that Figures IV and V gave for senior high school teachers of mathematics. Aside from being less pronounced and not as consistent, the trends in general, for the junior

THE VARIOUS AMOUNTS OF TRAINING ACQUIRED BY TEACHERS OF SENIOR HIGH SCHOOL MATHEMATICS SINCE BEGINNING TEACHING BUT BEFORE ENTERING THE PRESENT POSITION, ARE SHOWN AS PER CENTS OF THE TOTAL GROUP FOR EACH OF EIGHT DIFFERENT AMOUNTS OF CREDIT EARNED IN EDUCATIONAL THEORY. THE PER CENTS OF THOSE WHO HAVE EARNED ONE OR MORE SEMESTER HOURS OF CREDIT SINCE ENTERING THE PRESENT POSITION ARE ALSO SHOWN.

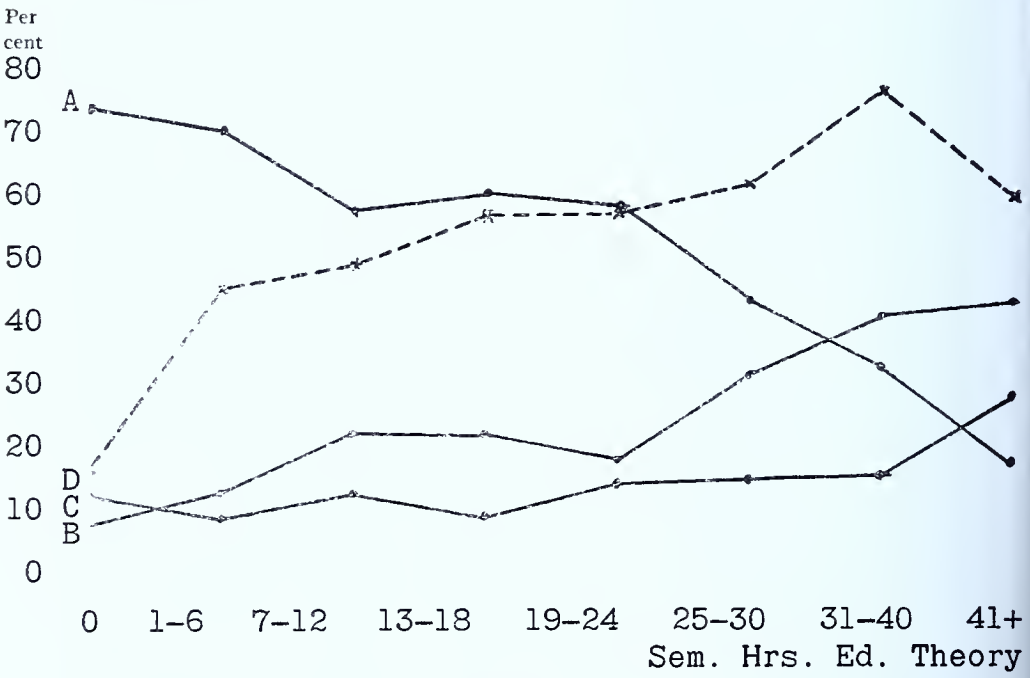

FIGURE IV

A— no training between first and present teaching positions
B— 1-2 yrs. training between first and present positions
C— 3-6 yrs. training between first and present positions
D— one or more Sem. Hrs. training since entering present position

THE VARIOUS AMOUNTS OF TRAINING ACQUIRED BY TEACHERS OF SENIOR HIGH SCHOOL MATHEMATICS, SINCE BEGINNING TEACHING BUT BEFORE ENTERING THE PRESENT POSITION, ARE SHOWN AS PER CENTS OF THE TOTAL GROUP FOR EACH OF SEVEN DIFFERENT AMOUNTS OF CREDIT EARNED IN ACADEMIC COLLEGE MATHEMATICS. THE PER CENTS OF THOSE WHO HAVE EARNED ONE OR MORE SEMESTER HOURS OF CREDIT SINCE ENTERING THE PRESENT TEACHING POSITION ARE ALSO SHOWN.

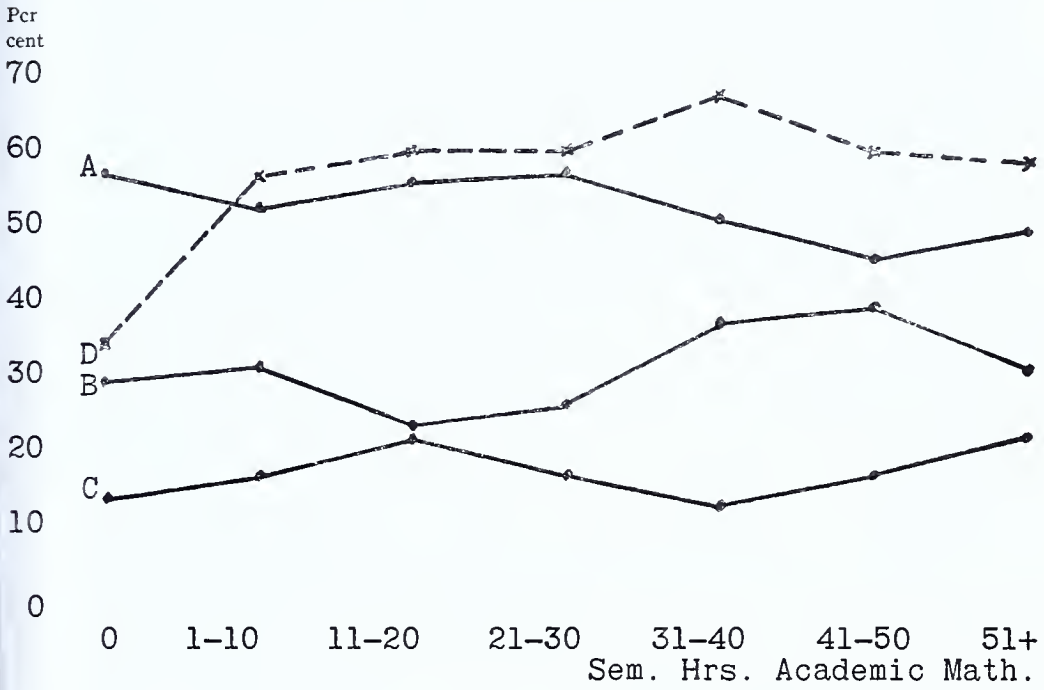

FIGURE V

A— no training between first and present teaching positions
B— 1-2 yrs. training between first and present positions
C— 3-6 yrs. training between first and present positions
D— one or more Sem. Hrs. training since entering present position

high school teachers are the same as they are for senior high school teachers. The junior high school teachers who have acquired three or more years of training since their first teaching form relatively high percentages of the two groups having small and large amounts, respectively, of credit in educational theory; they are small percentages of the group having 13 to 24 semester hours of credit in this field. While only 64 per cent of these teachers have studied since entering the present position, 80 per cent of them are found in the group having more than thirty semester hours of credit in the field of educational theory. In respect to academic

college mathematics those junior high school teachers who have extended their education form slightly higher percentages of the groups having more academic college mathematics than they do of the group having a small amount of such credit. As was true in the senior high school group of teachers, the junior high school group also seems to have extended its education in the field of educational theory more frequently than in the field of mathe-

THE VARIOUS AMOUNTS OF TRAINING, ACQUIRED BY JUNIOR HIGH SCHOOL TEACHERS OF MATHEMATICS, SINCE BEGINNING TEACHING BUT BEFORE ENTERING THE PRESENT POSITION, ARE SHOWN AS PER CENTS OF THE TOTAL GROUP FOR EACH OF EIGHT DIFFERENT AMOUNTS OF CREDIT EARNED IN EDUCATIONAL THEORY. THE PER CENTS OF THOSE WHO HAVE EARNED ONE OR MORE SEMESTER HOURS OF CREDIT SINCE ENTERING THE PRESENT POSITION ARE ALSO SHOWN.

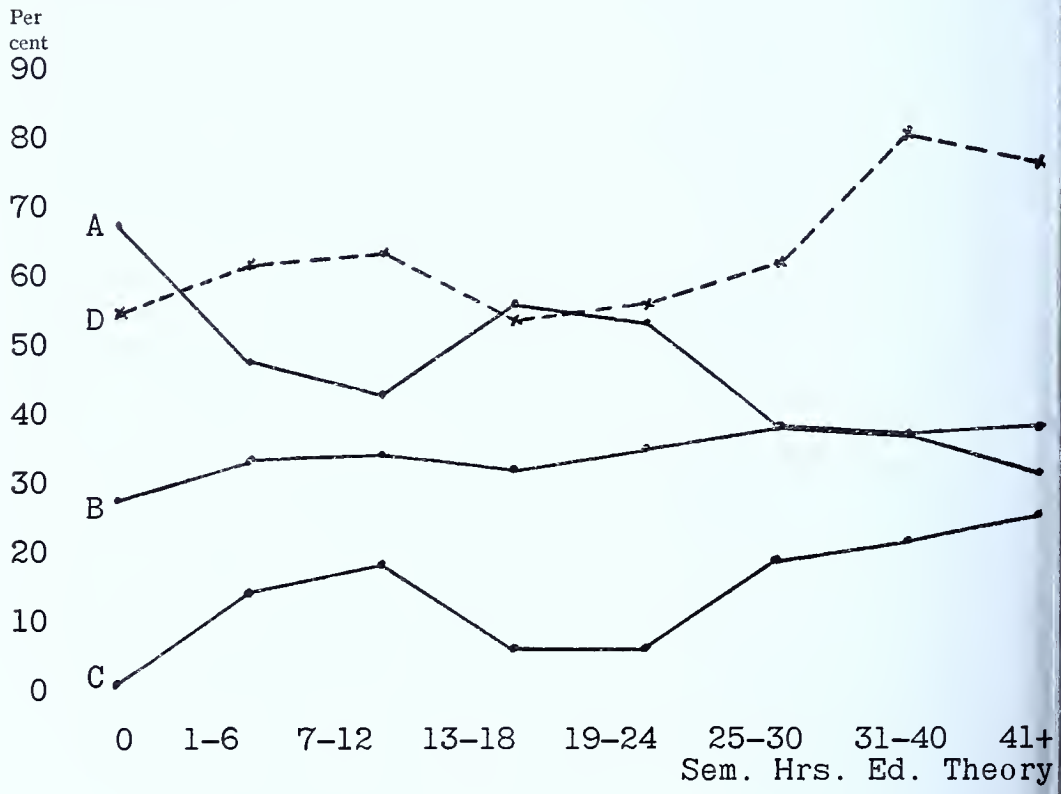

FIGURE VI

A— no training between first and present teaching positions
B— 1-2 yrs. training between first and present positions
C— 3-6 yrs. training between first and present positions
D— one or more Sem. Hrs. training since entering present position

THE VARIOUS AMOUNTS OF TRAINING, ACQUIRED BY TEACHERS OF JUNIOR HIGH SCHOOL MATHEMATICS SINCE BEGINNING TEACHING BUT BEFORE ENTERING THE PRESENT POSITION, ARE SHOWN AS PER CENTS OF THE TOTAL GROUP FOR EACH OF FIVE DIFFERENT AMOUNTS OF CREDIT EARNED IN ACADEMIC COLLEGE MATHEMATICS. THE PER CENTS OF THOSE WHO HAVE EARNED ONE OR MORE SEMESTER HOURS OF CREDIT SINCE ENTERING THE PRESENT POSITION ARE ALSO SHOWN.

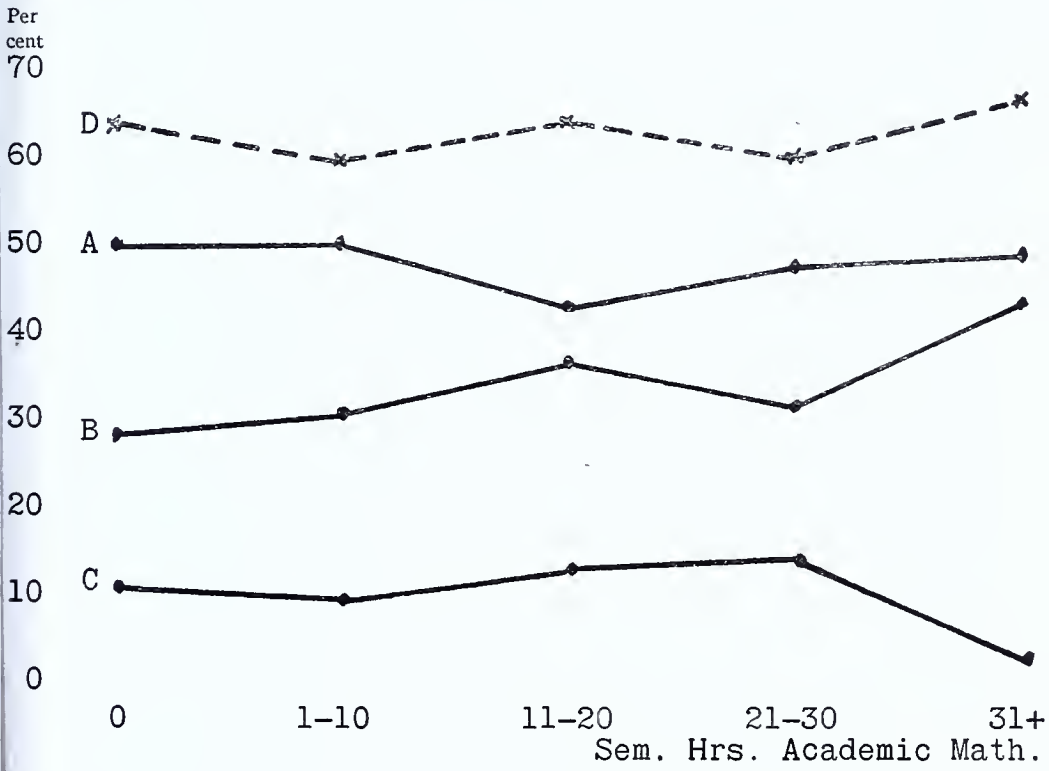

FIGURE VII

A— no training between first and present teaching positions
B— 1-2 yrs. training between first and present positions
C— 3-6 yrs. training between first and present positions
D— one or more Sem. Hrs. training since entering present position

matics. Perhaps this is not the most favorable situation because the junior high school teachers of mathematics have much less mathematical training than do the senior high school teachers. On the other hand it should be pointed out that their requirements are probably less. The larger portion of the mathematics in the junior high school curriculum is still arithmetic and the college mathematics courses are not closely enough related to this subject to either extend it or illuminate it to any great extent. Many of

the older junior high school teachers were formerly elementary teachers who were trained as such, and for this reason their mathematical background is meager while their background in educational theory is extensive.

The teachers who began their careers as elementary teachers have usually been trained in a normal school, while those who began as teachers in the secondary school have more often been trained in a college or university. An examination of the curricula of normal schools shows the extent to which both mathematics and educational theory are prescribed, and are offered for election in these schools.[2]

A crucial issue that is being raised and one which will have to be met not only by teachers of mathematics but by all other teachers in the high schools is whether any body of related materials such as mathematics should be organized into courses and taught as such, together with many implications, or whether a secondary school program should consist of a group of segments of human experience that are explored and participated in by the pupils. The former is traditional and is supported by experience and trial while the latter is currently in the ascendancy, partly because the former organization has proven unsatisfactory for large groups of our present high school population. In the latter type of school organization such elements of mathematics would be learned as are needed for the interpretation and understanding of the particular segment of human experience that is being explored. While human experience is constantly changing, the mathematical principles used in interpreting and advancing experience are not changing and for this reason the study of such a body of learning as mathematics is the more fundamental while the study of present experience deals primarily with the current exhibition of the fundamental principles.

Gauss expressed the fundamental role of mathematics thus: "Mathematics is queen of the sciences and arithmetic is queen of mathematics. She often condescends to render service to astronomy and other natural sciences, but under all circumstances the first place is her due."[3] And since the time of Gauss, researchers

[2]For a full analysis of normal school curricula see: Class, E. C., 1931. Prescription and Election in Elementary-School Teacher Training Curricula in State Teachers Colleges. New York: Teachers College Bureau of Publications.

[3]Quoted from: Bell, E. T. The Queen of the Sciences. 1931. Baltimore, The Williams and Wilkins Co. p. 1.

in fields far different from the natural sciences have discovered their dependence upon not only factual and manipulative mathematics but also upon the subtle quality of mathematical thinking which is required in the analysis, interpretation, and description of data and principles. The question for curriculum builders to consider is not "Shall the study of mathematics be included in the secondary school curriculum?" but rather, "What mathematics shall be taught, to whom shall it be taught, how shall it be taught, and by what kind of teacher?" Tremendous mathematical advances, many of which are comprehensible by secondary school pupils, have been made in the past three centuries and yet the secondary school curriculum contains to a large degree only the more ancient bodies of mathematical knowledge. While considerable study and experimentation in curriculum changes have taken place in some of our well known experimental schools such as the high schools connected with the Universities of Chicago, Michigan, Minnesota, and Teachers College, Columbia University, the organization of mathematics in the senior high schools of this country has, in general, not been altered materially in the past fifty years. The danger of unwise reorganization of curricula is well illustrated by the following paragraph found in Bell's *The Queen of the Sciences.*

> "In this connection there is an amusing bit of recent history. At one of the leading American universities the ambitious president had so thoroughly grasped Abel's precept about studying the masters in preference to their pupils, that he proceeded to put it into effect in the freshman class. To aid him in this worthy undertaking, the president called in a specialist in the teaching of science—not a specialist in science. Between them they made up a list of mathematical classics to be read by freshmen in their spare time. This included Newton's Principia of 1687 and Einstein's Theory of General Relativity and Gravitation of 1916. The last is quite a short trifle. It is the famous paper of which it used to be said that only twelve men in the world could understand it. The president is enthusiastic about the project. The freshmen have not yet been heard from."

The changing aims of secondary education must take into account the changing constitution of the school population as well as the potential worth of bodies of knowledge to be taught in the

Bell, op. cit., p. 12.

schools. Teachers of mathematics are already aware of the fact that all of the secondary school pupils cannot profit satisfactorily by studying the traditional courses in the traditional manner but these same teachers have not yet succeeded in developing necessary curricula for different pupil needs. This is one of the largest and most important problems that has been attacked sporadically but it needs a united attack by teachers and school officials who are alert to the challenges of current civilization and the potential benefits to be derived from the study of mathematics.

SUMMARY

1. This chapter is based upon a study of the training and experience of 1032 teachers of secondary mathematics in the public schools of the United States.

2. The amount of credit given to the same mathematics course differed widely in different institutions, with *college algebra* receiving from one to ten semester hours of credit.

3. Almost all of the teachers of secondary mathematics have studied *elementary algebra* and *plane geometry* in their own secondary school careers. The central tendency for both junior and senior high school teachers is near three units of credit in high school mathematics.

4. Among the younger teachers, newer courses such as *general mathematics* and *mathematical analysis* are frequently being studied.

5. Almost as great a percentage of junior high school teachers have studied freshman college mathematics courses as have the senior high school teachers. Beyond the freshman college year however, the junior group falls noticeably below the senior high school teachers in the pursuit of academic college mathematics courses.

6. The courses studied are more often algebraic in nature than they are geometric.

7. Approximately one-third of the junior high school teachers and more than one-half of the senior high school teachers have studied *college physics*.

8. A minority of students have studied *modern geometry* and a

small group of them have studied *college geometry* which in most cases implies *demonstrative geometry* based upon Euclid and the later extensions in the field.

9. Some professional mathematics course such as the *teaching of algebra* or the *teaching of high school mathematics* has been studied by approximately 50 per cent of all the teachers. Junior high school teachers have most frequently studied the *teaching of junior high school mathematics.* Likewise, the teaching of *senior high school mathematics* is studied most commonly by the senior high school teachers.

10. More than one-fourth of all the senior high school teachers have studied the *teaching of algebra,* and the *teaching of geometry.*

11. Approximately one-fourth of both junior and senior high school teachers of mathematics have studied no professional course in the field. Some have studied a general course such as *methods of teaching in the high school.*

12. Nearly one-third of these teachers of secondary mathematics have been engaged in some form of non-teaching work before entering the teaching profession. Only about 5 per cent have spent more than five years in that type of work.

13. In general, junior high school teachers of mathematics have more frequently been recruited from and have spent a longer time in elementary teaching than have senior high school teachers of the subject. Only 8 per cent of the senior group have spent more than five years in elementary teaching as compared with 34 per cent of the junior high school group.

14. A few teachers began their careers with no training beyond the elementary school level. These have taught in elementary schools before extending their training and becoming secondary teachers.

15. As many as 20 per cent of the junior, and 14 per cent of the senior high school teachers began their first teaching with only the equivalent of an ordinary secondary school course.

16. Almost 65 per cent of the senior high school group had obtained eight years of training beyond the elementary school before doing any teaching, while less than 30 per cent of the junior high school group had obtained a similar amount of education.

17. Approximately one-half of each group of these mathematics teachers entered their present teaching positions with no training added to that which they possessed when they began their first teaching. One year of additional training has been acquired by 15 per cent of each group.

18. Less than 20 per cent of each group have extended their training more than two years, after beginning teaching and before entering the present position. In general, these are the people who had lesser amounts of training when they began teaching, but some are in the group of those who had eight years of training beyond elementary school before beginning teaching.

19. When entering the present teaching position, the junior high school teachers had lower levels of training than did the senior high school teachers but they have done more to extend their training while in the present position.

20. A larger percentage of both junior and senior high school teachers voted courses in academic college mathematics important and valuable to them as teachers than they did professional mathematics courses. However, more of them had studied the former course.

21. Courses in educational theory were voted as valuable and important by a larger percentage of junior high school teachers than was either type of mathematics course. This was reversed by the senior high school teachers.

22. A minority of teachers expressed their lack of benefit from advanced courses in academic mathematics while another larger and more vehement minority expressed their lack of benefit from courses in educational theory.

23. Large majorities of these teachers of secondary mathematics claim that an understanding of boys and girls, their own hard work on the job, and their natural inclination for teaching, are significant and important characteristics that have helped to make them successful teachers.

24. Eighty-one per cent of the senior, and 62 per cent of the junior high school teachers of mathematics who have studied academic college mathematics rated these courses valuable and important to them as teachers. In general, those academic courses that come early in the college career and have a closer

relation to the high school work are rated as important and valuable by more teachers than are other academic courses.

25. *History of mathematics, theory of equations,* and *college physics* were some of the listed courses that received relatively high percentages of ratings as being definitely helpful *College geometry* was mentioned as helpful by many of the teachers who had studied it.

26. While more teachers have studied academic mathematics than professional mathematics, the percentage of those who studied each and found it definitely helpful is greater for the professional than it is for the academic courses.

27. In both the junior and the senior high school groups, the professional course the *teaching of algebra* was rated as definitely helpful by the largest percentage, and the course the *teaching of arithmetic* was so rated by the smallest percentage.

28. Because the content and the method of organization of professional mathematics courses differs so much in various institutions, the specific helpfulness of them cannot be determined.

29. The four courses in educational theory that were most frequently listed as helpful by secondary mathematics teachers are *psychology, principles of education, educational measurements including statistics,* and *methods of teaching,* with *psychology* the most frequently listed course. This preference is probably due to the frequency with which these courses are taught. The value of educational theory courses seems in many cases to be associated with the personality of the instructor.

30. More than 50 per cent of all those who have studied educational theory did not list any courses in this field as being definitely helpful to them as teachers of mathematics.

31. An analysis of teachers' statements about the reasons given by them for their success as teachers tends to center around the value of an adequate preparation in the subject to be taught. The value of well-directed observation and practice-teaching, the significance of understanding, and doing the job, are also given a high value. Apparently the genuine worth of having had good teachers and supervisors and a wholesome atmosphere in which to work are also appreciated.

32. Approximately two-thirds of the teachers of secondary mathematics have entered this teaching field because they liked the subject and wished to teach it.

33. Of the reasons given for not having studied more academic college mathematics, the most frequently checked was that the teachers had taken all that was offered or possible because of restrictions placed by the college in which they were students. Many who later became teachers of mathematics did not expect to teach this subject at the time they were attending college. Only 2 per cent of the entire group said that they did not like their teachers of mathematics or that they did not like mathematics.

34. A large group of teachers took what mathematics was required for college graduation in their particular course. Others did not study more mathematics because they did not wish to over-balance or over-specialize their undergraduate programs.

35. Teachers of secondary mathematics tend to consider that *elementary algebra* is taught primarily because it is necessary for a further study of mathematics and because it trains pupils to think abstractly with symbols, and secondly because it is directly useful in the life about us.

36. *Geometry*, according to the same body, is taught because it gives valuable practice in deductive thinking, trains pupils to think logically in life situations, acquaints them with geometric forms in our surroundings, and is necessary for college entrance.

37. The basic underlying objectives, in the teaching of demonstrative gometry in the secondary schools, need further study and clarification.

38. More than one-half of the junior, and slightly less than one-half of the senior high school teachers of mathematics claim that they do not read regularly any professional magazine in the field of mathematics.

39. *The Mathematics Teacher* is the most frequently read mathematical journal. *School Science and Mathematics* is read by a large minority of senior high school teachers, many of whom are located in the middle west.

40. The local state journal and the journal of the National Education Association are the two general professional journals read most commonly by teachers of secondary mathematics.

41. The majority of persons in this survey are teaching only mathematics. Others combine the teaching of mathematics with one or several fields. The number who teach in several fields is extremely small. The number of classes in mathematics, taught by teachers who instruct in some other field primarily, is also small.

42. Departmentalization of teaching is more highly defined and more rigorously pursued in the senior high school than in the junior high school.

43. In the junior high school, the courses are usually given such general names as *seventh year mathematics, eighth year mathematics,* etc. Whether these courses are what we now know as *general mathematics,* is not determined.

44. *Plane geometry* is more frequently taught in the senior high school than any other course, with *algebra* ranking a close second. Minor frequency courses are *solid geometry, advanced algebra,* and *trigonometry.* A few of the schools offer *analytic geometry* and *calculus.*

45. The non-mathematics teaching constitutes 30 per cent of the junior, and 18 per cent of the senior high school classes taught.

46. Senior high school teachers of mathematics who have acquired no further training between their first teaching and the present position form a relatively large percentage of those who have small amounts of credit in educational theory, while relatively small percentages of the group have large amounts of credit in that field. The opposite is true for both the teachers who have extended their education before entering the present position, and for those who have extended it while in the present position.

47. Senior high school teachers who have not extended their training show tendencies in respect to academic college mathematics which are much less marked but are slightly similar to the tendencies in respect to educational theory. From this statement, the inference may be drawn that teachers of senior high school mathematics are more noticeably extending their training in the field of educational theory than they are in the field of academic college mathematics. The junior high school teachers exhibit similar although less consistent trends.

CHAPTER V

CERTIFICATION OF TEACHERS

INTRODUCTION

The current population of teachers of secondary mathematics has already been described in chapters three and four. These teachers have received their education in the various normal schools and colleges of the country. Some of these schools were specifically organized for teacher training while others have found that with practically no change of organization and with the addition of a few professional courses they too have been able to continue as agencies for the preparation of teachers. Any institution of higher learning that provides those courses which meet a commonwealth's minimum standard for the legal certification of teachers may engage in teacher training. It is not even essential that the faculty of the institution, or any considerable part of it, be in sympathy with the objective of teacher training as one of the potential services that it can render to a commonwealth or to a more localized community. As has been shown in Tables 13 and 14, there are many different types of institutions engaged in the work of preparing mathematics teachers for the secondary schools. While the organization and the facilities of these training agencies differ more within each classified type than from one type to another, undoubtedly, in each of these types of institutions devoted to higher education there may be found colleges and universities that are outstandingly successful in the preparation of teachers of mathematics. Probably many of these are not admittedly teacher preparation institutions.

While the educational institutions that have prepared the teachers are directly responsible for the courses that these teachers have studied, nevertheless these institutions do not directly dictate which of their students shall be teachers and which of the prospective teachers shall be employed in certain schools. After the prospective teacher has been trained her employment

depends upon her satisfaction to either a local school official or a board of education or both of these. These local school officials may engage any teacher who is legally qualified and often because of local influences school officials select teachers who have relatively low qualifications. In this democratic country, the executive officer immediately in charge of a local school unit holds his own position at the will of a relatively small group of local residents who may or may not know what constitutes a good school and good teaching. In order to assure his own continued employment it is often necessary for the executive officer of a school to accede to local whims that may be derogatory to the best educational interests of the school. Frankly, the schools of many communities in the United States have not been entirely lifted out of the domain of politics. The greatest safeguards that have been established against the whimsical actions of local boards and local school executives as well, are the laws regulating the legal certification of teachers. However, these regulations, it should be remembered, control only the lower limits of preparation, below which teachers are not permitted to teach. Above these lower limits, individual schools may extend the qualifications demanded of teachers as far as they wish as long as these extensions are consistent with the availability of such teachers and with the communities' ability to pay for them in competition with other communities. Until we have evidence that the employing agencies are selecting the best available teachers, it is unfair to lay blame for the relatively low standards of preparation found in the teaching population of this country at the door of the school or college providing the preparation. We have evidence, as shown in the preceding chapter, that many teachers of mathematics are extending their education and they are doing this to greater amounts in the field of educational theory and to lesser amounts in the field of academic mathematics. To be sure there are graduate and undergraduate institutions offering both educational theory and academic mathematics but the teachers of secondary mathematics who are extending their training are more often studying the former type of work than the latter. If this is not wholesome it could readily be changed if the employing agencies, including the school principals, required their teachers to extend their education in academic fields. In the inquiry reported in the preceding chapter several teachers

charged that it is much easier to earn a master's degree in the field of educational theory than in the field of academic mathematics. If that is true, and if there is a point beyond which study in educational theory does not yield returns commensurate with the expenditures of energy and money involved, then corrective measures should be taken. Many of the arguments advanced by teachers against the value of educational theory are advanced by other teachers against the study of advanced courses in academic mathematics. There are many factors involved which require much critical study and perhaps some experimental treatment.

The powers of regulating the granting of legal certificates and licenses to teach on the various levels of instruction are not vested in the federal government and hence they are not uniform for the country as a whole. The various states and in some cases smaller local units have the authority to legislate and regulate the issuance of teaching certificates based upon qualifications that these regulating bodies have defined. Compilations of the qualifications for the various certificates issued by the several states show that over a period of years, "Certification, as a means of systematically and definitely raising standards of teachers and teaching is growing in recognition."[1]

According to a report made by a committee which recently investigated the raising of teachers' requirements and reported to the American Association of Teachers Colleges, "A study of American education as well as world education will reveal the fact that there has always been a close relationship between the legal certification requirements and the efficiency of public education."[2] This same committee cites evidence from a research study by Hydle which tends to show that one of the most desirable methods of increasing school efficiency is through raising the legal qualifications of the teaching profession.[3] If this evidence is reliable, certification should be accepted not only as a means of raising the minimum standards for new teachers but also as perhaps the most expedient method of stimulating the large minority of our teaching groups, who have merely met the present low

[1]State Laws and Regulations Governing Teachers' Certificates, United States Bureau of Education Bulletin, 1927, No. 19. For comparison see also United States Bureau of Education Bulletin, 1921, No. 22 and United States Office of Education, Bulletin, 1932, No. 20.

[2]The American Association of Teachers Colleges, Tenth Year book, 1931, p. 128.

[3]The American Association of Teachers Colleges, Tenth Year book, 1931. loc. cit.

minimum standards, to extend their education along desirable lines. Most of the larger cities have set up standards, which their new teachers must meet, that are significantly higher than the low standards for certification prescribed by the commonwealth in which these cities are located. That these same cities are able not only to find teachers to meet their higher requirements but also the fact that they often have long lists of applicants tends to show that to some extent at least, better trained teachers are available for other communities. The higher monetary reward and the different type of community activity in larger cities are forces that attract and stimulate teachers to further preparation. However, it is not in the smallest communities that we find the teachers with long experience and a relatively low level of training. Since the school systems have not provided the stimulation that has resulted in these older teachers seeking further educational light through formal study, the state certifying authority should make it mandatory for these teachers to attain higher levels of training than they actually do possess. Is it not entirely fair that as the levels of training are raised for new teachers entering a system, that the older teachers in the system meet these same standards?

An inquiry into the present state certification standards for junior and senior high school teachers was also made. A digest of this information has been prepared, and the obvious inferences and comparisons with the teaching population have been stated. These follow.

REQUIREMENTS AND PRINCIPLES

Although the general principles and trends in certification are apparently similar in all the states, there still is much disagreement in the number and kinds of teaching certificates issued by these states. While there are also disagreements in the qualifications demanded of teachers who teach upon the same level in various states, these differences are being lessened through the recognition of the common problems involved and through the growth of training agencies that are themselves being regulated on a national basis by such voluntary organizations as the American Association of Teachers Colleges. Because of the differences between states, no general reciprocal relationship covering exchange of certifications has yet been established. Reciprocity

in the matter of certification for teaching is now more commonly effected through the recognition of academic and professional training than by the simple exchange of certificates. Because the individual states are constantly amending and raising their requirements for the various levels of teaching, no compilation of these requirements for certification can be accepted as accurate for more than a short period of time after the compilation was made.

Perhaps the most commonly accepted principle of certification now in vogue pertains to high school teachers, and requires them to have attained a training equivalent to graduation from a standard college. The struggle for this requirement has taken place over a long period of years and has tended to become successful because it was fostered by strong regional and national bodies. The early goals and the trend toward the requirement of college graduation for high school teachers is apparent from the following excerpts from proceedings and committee reports which have been accepted as milestones in the struggle for high qualifications for secondary teachers.

In 1895—"the degree of scholarship required for secondary teachers is, by common consent, fixed at a collegiate education"[4]

In 1902—"the minimum scholastic attainment of all high school teachers (in the North Central Association) be the equivalent of graduation from a college belonging to the North Central Association of Colleges and Secondary Schools, including special training in the subjects they teach"[5]

In 1907—"the minimum requirement for a secondary-school teacher be graduation from a college maintaining a four year course and requiring four years' high-school work for admission, or . . . . equivalent requirements"[6]

To be sure the National Education Association can only recommend but its prestige and influence are sufficient to influence those authorities within whose domain certification of teachers falls. The North Central Association of Colleges and Secondary Schools, while membership in it is voluntary, has for a long time

[4]Proceedings of the National Education Association, 1895, p. 250.
[5]Proceedings of the North Central Association of Colleges and Secondary Schools, 1902.
[6]Proceedings of the National Education Association, 1907, p. 537

had sufficient prestige so that it has been the leader for higher standards in the states in which it operates. However this association has not made its regulations retroactive and there are within its jurisdiction, even to this date, many teachers who do not meet the standards prescribed. Although the North Central Association has been a leader, in 1925, 5.5 per cent of the academic teachers in accredited high schools in this association did not have the equivalent of a college education and more than 50 per cent of the non-academic teachers did not hold a college degree.[7] This is evidence that the goal set early in the century has not yet been reached.

In more recent years the trend has been in the direction of specifying the nature of much of the training, as well as the amount that is required for admission to high school teaching. The statement of the North Central Association in 1902 included "special training in the subjects they teach" but the nature of this special training has never been adequately and specifically defined. For more than a decade, many of the states have recognized that the teaching of certain non-academic subjects such as music, art, and manual training, etc., have required special preparation, and these states have been issuing special certificates which not only permit, but also limit, teachers to teach only these special subjects. For certification to teach the academic subjects, the only subject requirement that has been generally accepted is that of educational theory. While the tendency is toward special requirements in the particular academic field for teaching, such subjects as mathematics have not been widely adopted in respect to certification. Still, there has been an obligation on the part of school executives to engage teachers who have special qualifications for the positions within their schools. The trend in respect to the academic subjects was summarized in a Bureau of Education Bulletin in 1927 as follows:

> "Beside the very evident tendency toward requiring specialization in stated academic subjects to be taught, courses in secondary education, in "high school methods as prescribed in departments of education or teacher training institutions," and practice teaching in high school subjects, or in high school subjects taught, are required for certificates to teach in the secondary grades in a number of states."[8]

[7]Bachman, Frank P., Training and Certification of High School Teachers, 1930. Nashville, Tennessee, p. 8.

[8]State Laws and Regulations Governing Teachers' Certificates. United States Bureau of Education Bulletin, 1927. No. 19, p. 24.

The issuance of special certificates, which grant permission to teach one or several academic subjects for which special preparation has been made, has been delayed by the lack of coordination between the training and the employing agencies.

Because the junior high school division of public education has been introduced so recently; because it has not become a unit in the organization of education in most of the smaller communities and in some of the larger ones; and also because there is still disagreement among educators about the unique character of junior high school education, the move toward issuing certificates granting permission to teach specifically in the junior high school has been relatively slow. In 1932, only nine states issued a certificate distinct from the elementary or secondary certificates and specifically designed as a junior high school certificate.[9] It is interesting to note that in all of these states the certificate expires at the end of a given number of years and "may be renewed upon evidence of successful teaching experience and a number of semester hours of training in a university or teachers college."[10] In the states where a special certificate is not issued for junior high school teaching, the regular elementary and high school certificates overlap. The regular secondary school certificate covers the last year of the junior high school and is often valid in the elementary school as well. The elementary school certificate usually covers the first two years of the regular junior high school, and may often be extended to include work of the third year. The state certifying authorities have been making special cases of teachers who apparently are qualified but whose regular certificates do not cover all of the work that school principals wish them to teach. Of the states that issue special certificates for teaching in the junior high school, five require two years, two require three years, and two require four years of training beyond the regular four year high school course.

Of the states that do not issue a special certificate for junior high school teaching, the minimum amount of training required beyond the regular high school course, in order to qualify for a certificate to teach in all grades of a three-year junior high school is as follows: one state requires but one year, twenty-two states require two years, five require three years, and twelve require four

[9]The Preparation of Junior High School Teachers. United States Office of Education, Bulletin 1932. No. 20, p. 29.

[10]The Preparation of Junior High School Teachers. loc. cit.

years of training beyond the high school course.[11] If the schools in the states that have no special certificate for their junior high school teachers operate on a departmental basis, with teachers instructing in a particular field of courses rather than all of the different subjects in one school grade, it is necessary for teachers in the smaller schools to teach mathematics in not one grade, but in all the grades. This causes a hardship to teachers who have been trained for the upper grades of the elementary school and who may through further study be actually qualified to teach one subject, such as mathematics, in all grades of the junior high school, but who have not met the legal qualifications for the regular high school certificate. While the junior high school field is experimentally evolving with slightly different organizations in different cities, many school executives are choosing their teachers from present groups of elementary and secondary teachers, and in a majority of cases are encouraging them to advance their training in a special study of junior high school problems and in the subjects they are asked to teach. On the other hand, some of the units of organiation that are labeled junior high school offer the same type of work and teach it in the same way in which this is done in the corresponding grades of the traditional elementary and secondary school. If we have progressed sufficiently far in the junior high school movement, so that the better types of school organization are known as well as the corresponding qualifications for teachers, it would seem desirable and advisable for the state departments of education to define this unit more specifically, and to certify teachers for it.

It is very obvious from a study of the programs of junior high school teachers that many of them are called upon to teach too many different courses. Not only are the programs of these teachers exceedingly difficult from the standpoint of the total amount of work and the different types represented, but the training records show that these teachers are not adequately prepared in all of the fields they are required to teach. Such programs are more commonly found in the small schools and do not affect as many children as the number of teachers so engaged would signify. The satisfactory solution of this problem requires the cooperation of the junior high schools, the certifying authori-

[11]The Preparation of Junior High School Teachers. United States Office of Education, Bulletin 1932. No. 20, p. 30.

ties and the teacher-training agencies, so that not only new teachers may be properly prepared for junior high school work, but also so that those now engaged in teaching may better fit themselves for the new work.

In an attempt to make generalizations about certain matters of certification pertaining directly to teachers of secondary mathematics, a letter and a sheet of questions was addressed to the appropriate authority in each state. This sheet of questions (Form D, appendix) was designed after several printed sets of regulations governing the certification of teachers were examined. In many cases the answers to the questions were written directly on the question sheet, and in most cases the regular printed or mimeographed circular of information issued by the state was enclosed. A more critical study of the regulations of all of the states showed that some of the information sought could not be given categorically because of the overlapping and multiplicity of certificates for the same level of teaching. Junior high school teachers, as has already been shown, cannot be separated from senior high school teachers in most states. These two groups are both separately and commonly certified. In some states the high school certificates are valid in the elementary schools as well. The multiplicity of general and special certificates covering the same level of teaching is so great in some states that one unfamiliar with local conditions cannot fairly interpret the use of each of the different certificates issued. Even the printed regulations cannot in some cases be adequately interpreted. In 1927 Ashbaugh found that there were 121 different kinds of certificates issued for high school teaching in the different states.[12] Today the situation is nearly as complex and it becomes further involved by the introduction of a related system of high school accrediting by state departments of education.

The standards of preparation required of teachers in the accredited high schools are usually relatively high in comparison to the minimum standards for certification in the same state. This system of accrediting is merely another means employed by state departments of education for the encouragement and recognition of schools that are attempting to provide better educational facilities. Teacher preparation is only one of several important factors upon which schools are accredited. In at least one state

[12]Ashbaugh, Ernest J., Certification of High School Teachers. School Life, April, 1927. p. 155.

(Mississippi) the standards for accrediting schools are gradually being advanced so that teachers of secondary mathematics who were required to have nineteen and one-half semester hours of college credit in that field in 1931-32 will be required to have twenty-seven semester hours of credit in the school year 1936-37. This type of influence is distinctly forward looking and has the potentialities for significant effect because of its official status. If the accrediting of schools could be linked with the certification of teachers and be more generally applied in a larger number of states, it could be made a distinct force for elevating the qualifications of teachers and the greater professionalization of the profession. The rapid increases in collegiate enrollment, both undergraduate and graduate, that have taken place in the past decade, tend to support the contention that rapid advances in teacher preparation can be made in the immediate future.

In the inquiry it was found that practically all of the states had abolished the issuance of high school certificates on the basis of an examination conducted by the certifying authority. In general, all certificates for teaching academic subjects in the secondary schools are now issued upon the satisfactory completion of a prescribed amount of work in a recognized institution of higher learning. The length of the prescribed training period is usually four years of college study, in a few instances it is three years, and in one case it is five years of collegiate study for the regular academic high school certificate. There is a trend toward limiting the duration of these certificates to a specified number of years, with a provision for their renewal upon evidence of successful teaching, the completion of a prescribed amount of further study, or both of these. Patently, there are many degrees of successful teaching and there are many kinds of extended study, some of which are directly useful to a teacher of mathematics, and some which are only remotely so.

There is at present no marked tendency to issue high school certificates limiting the employment of teachers to a particular subject or group of subjects in the academic field. There is however a general practice of issuing specific certificates for teaching certain "special subjects" such as music, art, physical education, etc. These special certificates usually limit the holder to the particular field or fields for which he is trained. In one state the holders of these special certificates are allowed to teach in such

an academic field as mathematics if they have earned a minimum of fifteen semester hours of college credit in that academic field. There is some evidence of a trend toward specializing the general academic certificates so that teachers may instruct only in those subjects in which they have made some preparation in a college or professional school. Some of the states are now listing the college majors and minors on the face of the certificate in the expressed hope that employing officials will engage teachers who are definitely educated for particular positions. Thirteen of the forty-eight states have set up some definite subject requirement and are attempting to limit the scope of the certificates issued to teachers of mathematics so that such teachers have met some definite academic requirement in that field. These requirements range from "two courses" to a college minor or major. The remaining thirty-five states that do not expressly limit their certificates to certain teaching fields issue the general academic certificate which, in general, is equally valid for all of the academic subjects in the high school. The requirements for this general academic certificate that pertain to mathematics teachers are in the nature of required majors and minors in the college course. In most cases however, there is no direct statement which in any way requires the holder to teach only those subjects for which he has prepared. From the evidence previously cited in this study, it may be concluded that employing officials in the local school units of the different states have been selecting many teachers who are not specifically prepared to teach mathematics.

At the present time, the completion of a four year college course which includes a minimum required amount of credit in educational theory constitutes bona fide legal evidence of ability to teach mathematics and other academic subjects in the secondary schools of most states. That this is not adequate preparation for a teacher of mathematics is apparent from the fact that of fifty-seven selected universities and liberal arts colleges that were chosen to represent all sections of the country, various types of institutions, and the better practices in the education of teachers, only 31 per cent have requirements in the field of mathematics.[13] That this is serious may be inferred from the following statement by Peik in his report on Teacher Education Aims, "The percent-

[13]Peik, W. E., Courses for High School Teachers, School Life, December, 1932. p. 71.

age of liberal arts college graduates who go into teaching, according to Meyer in the study cited, has risen from 18 per cent in 1900-1904 to 45 per cent in 1925-29."[14] If mathematics is to be continued as a subject for study on the secondary level, teachers should be prepared to teach it and school executives should be required to engage those teachers who are prepared.

All of the states now require some study in the field of educational theory for their highest academic certificate which is issued to teachers entering high school teaching. While two of the states at present require only six semester hours of credit in this field, the majority of the states require between fifteen and eighteen semester hours. Also, the number of states requiring a small amount is decreasing and there is some evidence that twenty-four semester hours is the goal set by many states. Many of the states list the different courses in this field that are required for study or accepted as meeting the requirement and several states define the range of credit that may be granted for each of the different courses. Thirty of the states now have a definite requirement of directed observation or practice-teaching or both, with a typical credit requirement of three semester hours for this type of work. From a comparison of the present requirements to those of several years ago there is evidence of a strong trend not only toward requiring practice-teaching but also toward certain stipulations as to the methods of and the facilities required for carrying out this requirement. From the statements of mathematics teachers as to the helpfulness of their work in practice-teaching it may be concluded that the value derived from observation and practice-teaching depends much upon the way in which the work is conducted. The trend toward more rigorously defining the nature of practice-teaching as well as the requirement of this type of work is gratifying. Several states waive their requirement of practice-teaching when the student has had successful teaching experience. A few states will not credit any past experience as practice-teaching. From the statement of teachers the latter procedure may be inferred to be the better educational practice providing the schools have adequate methods in and facilities for carrying on this type of work.

Among the professional courses that are being required more frequently now than formerly, is the special methods course in

[14]Peik, W. E., Teacher Education Aims, School Life, May. 1933. p. 167.

the field of major interest. For those who major in mathematics, this is constituted by such a course as the teaching of high school mathematics. If it could be assured that mathematics majors teach mathematics and the English majors teach English, this requirement should be commendable. Inasmuch as it constitutes an application of educational theory rather than the abstract theory, this should in most cases be a satisfactory course for teachers in training.

The large number of small high schools spread throughout the country have had an effect upon certification of teachers and indirectly have a bearing upon mathematics teaching. In the organization of curricula for these schools, an attempt has often been made to provide for general academic education as well as immediate vocational training. Because of the small number of teachers in each school it has been necessary for most of them to give instruction in several fields; fields for which they often have not been prepared. Bachman has made a thorough study of the educational offerings of small high schools and he concludes, "It is probably better both for the child and for the community to omit altogether or to treat incidentally certain high school studies and activities than to attempt to give them a regular place in the curricula with teachers inadequately prepared or wholly unprepared to teach them."[15]

Bachman also shows how to meet this situation and has prepared sample curricula for small high schools exhibiting the combination of general academic work with one vocational field so that no teacher is required to give instruction in more than two subject fields. Until the principals of schools in small communities recognize the necessity for sound educational offerings and are willing to deny political expediency, the only sure means of raising the calibre of training that individual teachers bring to their classrooms, is through the legal expediency of more highly defined certification standards.

SUMMARY

1. Because the power of granting teachers' certificates is vested in the several states and not in the federal government, there are many different kinds of certificates issued to high school

[15]Bachman, Frank P., Training and Certification of High School Teachers, 1930. Nashville, Tennessee. p. 69.

teachers. Likewise the legal requirements for these certificates differs considerably among the various states.

2. The raising of the legal qualifications for entering the teaching profession by means of certification standards is believed to be an effective method of increasing school efficiency.

3. Local communities can, and often do, require higher qualifications than those set for minimum certification standards by the state. In general, the larger communities have higher standards for teachers than do the smaller ones.

4. The practice of issuing teachers' certificates through an examination set by the certifying authority is being discontinued. Certificates are now most commonly issued on the basis of educational training.

5. In general, certificates for teaching in high school are based upon four years of college training, which includes between fifteen and eighteen semester hours of credit in the field of educational theory. This training standard has been a goal in many sections of the country for more than thirty years, but it has not yet been attained by all of the teachers who are now in service.

6. Certificates to teach the "special subjects" are now issued in most of the states. These require the candidate to have specific preparation in the special field for which the certificate is issued, and limit him to teaching within that field.

7. In the main, special requirements in the field of academic college mathematics have not been set up for teachers of secondary mathematics. These teachers are granted a general academic certificate, for which the only requirement that is common to all states is that of a stated amount of credit in the field of educational theory. There is a trend toward requiring teachers of mathematics to have special preparation in this field before they are certified to teach the subject.

8. Only nine states issue a special certificate for junior high school teachers. In most states the regular elementary and high school certificates extend into the grades of the junior high school. The scope and practice of the junior high school should be better defined, and certificates should be issued for teaching therein.

9. There is a trend away from certificates which cover all levels

of teaching, and also from those that are valid for the life of the individual. Instead, the inclination is toward special certificates for teaching on a limited level. These certificates, now being issued, are limited in duration and may be renewed upon evidence of successful teaching, further study, or both of these.

10. The rapid increase in the enrollment in institutions of higher learning suggests that certification standards for academic teaching fields in the high schools could be raised materially, without a shortage of qualified teachers resulting.

11. Thirteen of the forty-eight states now definitely require teachers of high school mathematics to have some academic college preparation in this field.

12. Many states require that the college fields of major and minor study be written on the face of the certificate in the expressed hope that school officials will choose teachers accordingly.

13. The granting of a general academic high school certificate based upon college graduation does not insure adequately trained teachers of mathematics, because only 31 per cent of the colleges require mathematics for graduation, and 45 per cent of the college graduates are becoming teachers.

14. Thirty states have a definite requirement of some form of apprentice or practice-teaching. A tendency toward requiring training agencies to provide adequate facilities for this work is indicated.

15. There is a tendency to specify some of the separate courses in educational theory that are accepted to meet the requirement in this field. Among these specified courses, a usual one is a special methods course in the field of major interest. This course for mathematics majors is generally designated *methods of teaching high school mathematics.*

16. The large number of small high schools that have been hampering the requirement of special preparation for certification to teach in special academic fields like mathematics, should and can offer curricula for which they can secure adequately prepared teachers.

17. When the rapid growth of the secondary school enrollment is taken into consideration, the progress that has been made in

certification of teachers in the various states during the past thirty years is remarkable as well as significant. There is much evidence that this progress will continue. It would be desirable for some national coordinating agency, such as the Federal Office of Education, to give constructive suggestions for the issuance of certificates regulating teaching in the secondary schools, so that the basic certificates issued in the several states may have greater agreement. The problems of secondary education in the various states are believed to be more similar than they are dissimilar.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION AND SCOPE

During the past fifty years, methods of living, of travel, of communication, and even of thinking, have changed for large masses of people. The urbanization of a large portion of the whole population, together with the complex developments in social and economic living have made community cooperation not only desirable but imperative. The ability to isolate and to think intelligently about the issues and problems of modern life probably requires a broader and more thorough educational training than the public elementary schools of the nation are able to provide. Teachers of mathematics in secondary schools of the United States face the problem of providing a type of mathematical education that is functional not only in narrow technical channels but also in the broader interpretation of current living.

The mathematics of our secondary schools cannot be evaluated in direct comparison to that of the European countries unless we can demonstrate that it should serve the same purpose. Certainly the secondary school population of our country is differently constituted from similar populations in Europe when these are considered in relation to the whole population. This is apparent from the following statement by Commissioner Cooper of the United States Office of Education:

> "Within a period of 30 years the high school enrollment has increased from a little over 10 per cent of the population of high school age to more than 50 per cent of that population. This enrollment is so unusual for a secondary school that it has attracted the attention of Europe, where only 8 or 10 per cent attend secondary schools."[1]

This rapid growth of enrollment has probably been attended by a less rapid advance to higher qualifications for teachers than could, or perhaps would, have been effected had the enrollments increased only in proportion to the increase in general population. During the 30 year period referred to by Commissioner Cooper,

[1]United States Office of Education Bulletin. 1932. No. 17, p. v.

the content of curricula has changed somewhat; new subjects have been added and others have been dropped. However, the content and organization of textbooks in secondary school mathematics have changed very little during this period. This may be interpreted as evidence that during a changing civilization the fundamental mathematical concepts continue to be true and to be applicable or it may be interpreted as proof that mathematics teachers are very conservative and loath to change. The place of mathematics, in a secondary school system that has already enrolled more than one-half of the available population and which is still enlarging, must be determined in relation to the larger fundamental aims of secondary education and in light of the contributions that courses in mathematics may offer toward the achievement of those aims.

In actual school practice, the teachers of secondary mathematics and the problems concerning them should not be separated from the larger and more conclusive problems and issues that confront not only secondary education but also the entire field of educational theory and practice. In this study however, it has been necessary to curtail possible extensions and implications to the teachers of the one subject, even when there has been evidence that the implications pertained to academic fields other than mathematics. In this concluding chapter, conclusions and recommendations concerning the teachers of secondary mathematics will be limited to three main phases that have close and direct bearing upon the teaching of mathematics. These phases are: first, the nature and purposes of the study of secondary mathematics; second, the education of teachers of the subject; and third, the certifying of teachers by local state authorities. The first of these phases has not been a direct part of this study and no attempt has been made to make final recommendations concerning it, but implications showing the type of further research that should be done in this field are apparent and are stated. The material gathered for this study has made it possible to offer definite conclusions and recommendations concerning the training and certification of teachers of secondary school mathematics.

MATHEMATICS FOR SECONDARY SCHOOLS

While the origins of mathematics are obscure and remote, this branch of learning probably arose through a recognition for the

necessity of counting and measuring. These concepts are immediately practical, they are most commonly employed by primitive peoples, and are probably the two most basic concepts that can be found in the whole field of mathematics. Many of the algebraic and geometric theorems that have been discovered are merely extensions of the two more basic concepts and provide means for counting and measuring under peculiar conditions by less direct methods. Simple direct counting and measuring under primitive conditions sufficed for primitive societies but they are insufficient for the technological era that has evolved. In this technological age with its attendant complexities of social and economic living, the opportunities for thinking, dependent upon and facilitated by the knowledge of mathematical concepts and theorems, are ever increasing. The recognition of this situation forms the basic reason for including the study of mathematics in school curricula.

The growing practice of considering the elementary school as composed of a kindergarten plus six years of elementary instruction curtails the mathematical offering that formerly was given in the eight-year elementary school. On the assumption that the mathematical offerings of a six-year elementary school cannot be sufficient for intelligent participation in ordinary living, the secondary schools have developed curricula in this subject. The immediate or the remote practical value of existing curricula will not be discussed, for this in itself depends upon a series of definitions that are not pertinent to the present study. Because mathematics is now being taught and probably will continue to be taught in the secondary schools, the issue concerning the type and purpose of such study must be raised even though it is not answered here.

With the increase in the number of new courses that are being taught in the modern non-vocational high school, the more traditional subjects such as mathematics are being required to justify their inclusion in the curriculum. Some of this change in curricula may be attributed to a spirit of the times, particularly manifest during the third decade of the present century during which there has been a marked tendency for expansion and for a trial of new things in the hope that they might be beneficial to the pupils. The statistics of public high schools that are assembled biennially by the United States Office of Education show

that in 1910, *algebra* was studied by 56.9 per cent of the pupils in regular four-year public high schools and in 1929 by 35.2 per cent; that *geometry* was studied in 1910 by 30.9 per cent of the total high school enrollment, and by 19.8 per cent in 1928.[4] Furthermore, mathematics teachers now, as in the past, admit that one of the main reasons for teaching *algebra* and *geometry* on the secondary level is for their value in a later study of mathematics and its attendant requisite for college entrance. With the exception of certain college departments such as engineering and science, the general trend since 1924 has been toward lowering the college entrance requirements in mathematics.[5] This lowering of college entrance requirements is very apt to be reflected in the secondary schools whose general academic curricula still enroll the majority of all secondary school pupils. Whether the mathematical offering of a school should be determined on the basis of the type of curriculum offered or on some other basis, such as the mentality of the pupils in the school, is one of the serious questions confronting both teachers of mathematics and others interested in curriculum making.

This problem has recently been restated with suggestion by Professor Beatley in an article in the Eighth Yearbook of the National Council of Teachers of Mathematics in which he writes:

> "Each of these courses of study (one for superior and one for inferior students) would contemplate the possibility that students might not complete them. They would be devised as far as possible to give in each succeeding grade the most important subject matter in mathematics for the pupils in question. This plan does not deny the value of separate curricula for students looking forward to commerce, industry and other specific vocations. It asserts merely that the vocational differentiation between curricula ought not to apply in any large measure to the mathematics of these curricula; that in mathematics diversity of vocational aim is much less significant than difference in mental power."[6]

Even if there were general agreement among mathematics teachers that the plan suggested by Professor Beatley should be

[4]Statistics of Public High Schools (1927-1928). United States Office of Education Bulletin, 1929, No. 35. p. 9.

[5]Articulation of High School and College. 1932. United States Office of Education Bulletin, No. 17, Monograph No. 10. p. 37.

[6]Beatley, Ralph: Coherence and Diversity. 1933. The Eighth Yearbook of the National Council of Teachers of Mathematics. New York City. p. 171.

adopted, there are still many further questions which would have to be answered before the mathematics teachers could agree upon the curriculum content of the various courses offered.

The National Survey of Secondary Education has currently issued a monograph devoted to instruction in secondary mathematics.[7] This monograph is more concerned with statistical tabulations of the mechanical details of syllabi and courses of study of that have been issued by state and local school units than it is with the actual plan, organization, and methods of instruction of the different courses in mathematics. From several of the tables however, it is possible to gain an idea of the various courses that are being taught in high schools and some of the topics treated in these courses. In comparing the content of curricula now being offered with the content of textbooks of several decades ago, one finds remarkably close agreement. From this, one might infer that the content of secondary mathematics courses from the standpoint of topics treated has changed little during the last thirty years. An analysis of the topics of research in the field of teaching of mathematics reveals that the greater activity during the past five years has been directed toward rearrangements of materials and of shifting emphases of content, rather than upon seeking a better actual content of courses in mathematics for secondary schools.[8] The latest of these bibliographies (school year 1930-1931) lists twenty-five studies that deal with methods of teaching, organizing, and arranging the content of *plane geometry*, with not a single research suggesting that some *geometry* other than the traditional Euclidean might have as much value for secondary pupils as the one now taught universally.

In general, research in the teaching of mathematics is being directed toward a more intensive study of the status quo. Most of this research is done under the supervision and direction of professors in the graduate schools in which students are working for advanced degrees.

During the preparation of this report, many questions that are indirectly related to the teachers of secondary mathematics have been suggested. Some of these deal directly with the nature of secondary mathematics and the content and organization of

[7]Instruction in Mathematics. 1932. United States Office of Education Bulletin, No. 17, Monograph No. 23.

[8]See the bibliographies of research studies in education that are published annually by the United States Office of Education.

curricula of the subject. No doubt all of these have previously been attacked in the thinking of independent researchers, and have been encountered by groups engaged in the building of syllabi. The following are suggested as basic problems in secondary school mathematics.

1. What are the basic objectives that can actually be achieved in the teaching of different parts of the entire field of mathematics in the secondary school?

2. Are the mathematical needs of students in vocational high schools sufficiently different from those of students in non-vocational schools so that these two groups should be taught a significantly different content?

3. For the general academic student, how many units of mathematics should be required in the course and how much should it be possible for him to elect?

4. How much and what kind of mathematics should be required of the pupils of lower mental levels who are increasingly a part of our secondary schools?

5. To what extent should mathematics courses in the junior high school be exploratory and appreciative in nature, to the possible sacrifice of actually acquiring mathematical training?

6. Is it feasible for all secondary schools (including both junior and senior high schools) in all communities of the country to offer a common core of mathematical materials which should be required of all pupils in these schools?

7. General mathematics has met with some success in the junior high school and with greater failure in the senior high school. Does the apparent failure in the senior high school of general mathematics imply that the issue has been determined?

8. What realignment of phases of the whole field of mathematics can be made for the secondary curriculum so that students will gain more facility in using mathematical skills as well as greater power of analysis and insight than are now possible under the traditional arrangement and content of courses?

9. Are there arithmetical materials, both cultural and practical, that are being excluded from the secondary curriculum because commonly arithmetic is either exluded entirely or it takes the form of business arithmetic?

10. Should mathematics as a separate part of the secondary curriculum be discontinued entirely and the materials of mathematics be taught only as they are called into use by other more inclusive phases of living?

As has been indicated, the preceding questions have been considered and partially answered by individual teachers but as yet there is no evidence that the large mass of teachers is in agreement with the leaders in the field. The most hopeful indication at the present time is the extensive activity in local organizations of mathematics teachers as well as regional and national bodies. The outstanding national body, The National Council of Teachers of Mathematics, through its annual meetings, its magazine—*The Mathematics Teacher*—and its annual yearbooks, is doing more to stimulate interest in the organization and teaching of mathematics than any other single agency and probably more than all other agencies combined. One of the best means of extending this influence in the reawakening of the teachers themselves would be to extend the membership of the National Council so that it would include the majority rather than the minority of secondary mathematics teachers.

There are now in existence several different bodies and agencies that should be tremendously interested in the content and teaching of secondary mathematics. The most outstanding of these are:

1. Voluntary local, sectional, and national organizations of teachers of mathematics.
2. Curriculum revision committees that have local or statewide scope.
3. Graduate students who are working on theses for advanced degrees in graduate schools of mathematics or education.
4. Professors of the teaching of mathematics, and field workers who are concerned with these problems.
5. Classes and graduate seminars in the teaching of mathematics.
6. Professors of mathematics in the liberal arts colleges and universities.

The first four of these groups are well represented in lists of research studies dealing with the teaching of secondary mathematics. Although the professors of mathematics in the liberal arts colleges and universities have trained more teachers than all other agencies combined, the number of research studies in the teaching of mathematics made by this group is comparatively small. Even the textbooks in secondary school mathematics,

which formerly were written by mathematicians connected with the colleges, are now being written by teachers in the secondary schools.

Syllabus committees in different states and cities have been enlisting the services of the best known teachers of secondary mathematics and they have probably done as much toward rearranging the traditional materials and including new materials as any other group. The publication of syllabi so that they are made available to teachers in other localities is a valuable aid in stimulating a better type of teaching of the subject. One of the newer organizations of the material of elementary mathematics is that presented by Betz in the Eighth Yearbook of the National Council of Teachers of Mathematics[9] and taken from the 1931 edition of the Tentative Syllabus in Junior High School Mathematics issued by the University of the State of New York.[10] This organization places the usual courses in secondary mathematics in the following arrangement:

Calculus

Analytic Geometry

Trigonometry

Algebra Demonstrative Geometry

Numerical Trigonometry

Arithmetic Intuitive Geometry

While other states and local cities have been as busily engaged in syllabus building as New York State and have done as significant work, the New York State syllabus actually affects more teachers and pupils than any other single syllabus.

Attention should be called to the large number of independent studies that are classified as research in the teaching of mathematics by the United States Office of Education. During one school year (1930-31) nearly two hundred studies were reported

[9]Betz, William: The Teaching of Intuitive Geometry. 1933. Eighth Yearbook of the National Council of Teachers of Mathematics. p. 60.

[10]The University of the State of New York corresponds to the state department of education in other states.

not including those published in professional magazines. The majority of these studies were theses written by graduate students in partial fulfillment of the requirements for masters' and doctors' degrees. The lack of a generalized direction and coordination of these studies is apparent from the overlapping of their scope and material. For instance, during a fourteen-month interval in 1929 and 1930, three master's degrees were granted in different sections of the country for analyses of textbooks in *algebra* and during the same interval two master's degrees were granted for analyses of workbooks in *algebra*. Of greater importance than this duplication of effort is the fact that only a few of the more-than-five-hundred studies made during the past five years are readily available to teachers of mathematics generally. Some agency such as the National Council of Teachers of Mathematics should undertake the job of critically analyzing the validity and reliability of these research studies and should publish the findings of those studies that give evidence of general usefulness. One such attempt has been made by Benz in the last yearbook of the National Council but his summary deals primarily with a restricted group of studies reported mainly in magazines. The need for a critical and comprehensive summary of research dealing with the teaching of secondary mathematics still exists. At present, the large majority of such studies are filed away in the libraries of the colleges and universities for whose degrees the theses were written.

Because the National Council of Teachers of Mathematics is the only national organization dealing primarily with the problems related to the teaching of mathematics in the secondary schools, greater cooperation should be realized between that organization and the educational institutions that are guiding the advanced professional study of teachers of this subject. It should be possible for the National Council, through a committee, to coordinate many of the research studies that are now being made. The professors under whom this work is done and the students who are actually doing the research work are usually members of the National Council and thus it should not be difficult to coordinate the work of both of these agencies. Outstanding studies that have significance for a large percentage of the teachers in the Council should be made available in printed form. Perhaps it is not unfair to charge the duplication of studies as well as the

piecemeal variety of them to the professors who are directing or supervising them, for surely it is their obligation to know what has been done and what is being done in the field.

EDUCATION OF TEACHERS

If the teaching of mathematics in a secondary school may rightly be considered professional work, then it is fair to assume that preparation for this work should involve specific types of educational activity that will not only fit the candidate for this work but it should also point the way for continued growth after the initial training period. Probably the most important phase of the training of a teacher of mathematics should be his background in the subject he teaches. As has been shown already, the actual mathematical background of many teachers in both the junior and senior high schools, is very meager and some of them have studied no mathematics beyond that taught in the usual secondary school. It has also been indicated that the qualifications of the teaching staffs in some communities are higher than in others, and that individual school units may set higher standards than those required by the state certification authority. Employing officials do not always employ the teachers with academic and professional backgrounds that best fit them for the particular position in which a teacher is needed. The wide range of subjects that teachers are often called upon to teach, especially in the smaller communities, is probably due to an unwise attempt on the part of the local school officials to offer to a small group of students a variety of academic and vocational study that is unwarranted because of the lack of properly prepared teachers and of necessary school equipment. No teacher should or needs to teach in more than three subject fields if the school curriculum is properly arranged and suited to the better educational needs of the community. Even in small communities, where three or four high school teachers are employed, it should be possible to arrange the courses in the curriculum so that no teacher instructs in more than two different subject fields. Finally, teachers should be employed and permitted to teach only in those subject fields in which they have made a definite amount of academic and professional preparation.

At the present time we have two nominally different types of institutions engaged in the preparation of teachers of secondary

mathematics. They are the normal schools and teachers colleges that are maintained primarily for teacher-training purposes, and the colleges and universities that actually do a large amount of teacher-preparation even though they are primarily schools of the liberal arts, or professional schools of a non-teacher-preparation type. In respect to the training of mathematics teachers for the secondary schools, the main factors in these two types are the teachers colleges and the liberal arts colleges. In reality the courses in these two types of schools are very similar, and the methods of teaching are similar. Probably their widest difference exists in the greater significance given to practice and apprentice-teaching in the teachers college. Peik has described their similarity thus, "The two types of schools, so far as the exterior pattern of the education of four-year-high-school teachers is concerned, are moving toward each other rapidly and in a number of respects have almost met."[11] In respect to the faculties of these two types of schools, Professor Evenden in reporting the findings of the National Survey of the Education of Teachers, pointed out that " . . . . the number of faculty members in teachers colleges and normal schools . . . . with one or more years of graduate work compares very favorably with the faculties of other higher educational institutions. The comparison is not so favorable, however, when the percentages of faculty members with three or more years of graduate work are considered."[12]

Although the amount of training possessed by teachers college faculties, as pointed out by Professor Evenden, compares favorably with that of liberal arts college faculties, there is no assurance in this statement that the teachers of mathematics in the teachers colleges are sufficiently prepared to give the instruction needed by high school teachers of the subject. In studying the training of teachers college faculties, Cook secured transcripts of the training of 1428 faculty members in forty-two teachers colleges and normal schools located in twenty-seven states. All of these institutions were members of the American Association of Teachers Colleges. In this group there were fifty-eight teachers of mathematics who had a median of twenty-three semester hours of undergraduate credit in mathematics and a median of four semester hours of

[11]Peik, W. E. Teacher Education Aims. School Life, May 1933. p. 167.

[12]Evenden, E. S. 1933. Findings of the National Survey of the Education of Teachers: Implications for the Improvement of Current Practise. Twelfth Yearbook, 1933. The American Association of Teachers Colleges. p. 110.

graduate credit in this field.[13] Dr. Cook concludes that " . . . . the teachers in teachers colleges who are training teachers for high school positions have relatively the same collegiate preparation as required for high school teachers. These conditions should be remedied by requiring faculty members to earn additional semester hours of graduate credit in the specific subject preparation."[14] If the findings of Professor Evenden and of Dr. Cook are both valid, it must be concluded that teachers college faculties have been studying in fields other than the one they teach. The Tenth Yearbook (1931) of the American Association of Teachers Colleges which was published the same year as Dr. Cook's study gives that organization's standards for accrediting. It reads in part, " . . . . graduation from a college of recognized standing and additional training which shall include at least one year of study in their respective fields of teaching in a recognized graduate school . . . . "[15]

Such a general statement of standards was inadequate as Dr. Cook's study has shown, and more recently (1933) the statement of the association reads " . . . . possession of a master's degree or its equivalent. Preparation should include at least 24 semester hours of undergraduate and/or graduate work in the field taught and also professional courses in the field."[16] No doubt these standards will continue to be raised in the future until they more nearly approach those already being achieved by several of the outstanding teacher-training institutions where the offering in mathematics is a full academic major.

The teachers colleges generally give evidence of a professional spirit and purpose which is often lacking in the typical liberal arts colleges and which is an important factor in teacher-preparation. Professor Evenden points out that, " . . . . more of the faculty members of normal schools and teachers colleges have had experience in elementary and secondary schools and for longer periods than have the teachers in the colleges and universities . . . . "[17] The possession of a professional atmosphere and purpose should be one of the prime requisites for a school engaged in teacher-

[13]Cook, Harris Malone. 1931. The Training of State Teachers College Faculties. George Peabody College for Teachers, Nashville, Tenn. Table No. 17, part 2, p. 117.

[14]Cook, Harris Malone. op. cit., p. 128.

[15]The American Association of Teachers Colleges, Tenth Year Book, 1931. p. 11.

[16]The American Association of Teachers Colleges, Twelfth Yearbook, 1933. p. 21.

[17]Evenden E. S. op. cit., p. 110.

preparation, and the understanding of problems of instruction on the secondary level is perhaps best attained through actual teaching on that level. Practically all normal schools and teachers colleges require practice-teaching, and require it in almost all fields, while 25 to 40 per cent of the colleges do not require it.[18]

Because of the general similarity between teachers colleges and liberal arts colleges and despite the lack of professional atmosphere often observed in the latter, and the relatively low level of academic training found in the former, both these types of institutions should probably continue in the work of preparing teachers of mathematics for the secondary schools. Because of the increasing percentage of college graduates who are entering teaching, it will probably be easier to further professionalize the colleges than it will be to advance the faculties of the teachers colleges. The former probably can be accomplished more readily through the regulation of certification standards than the latter.

While it is recognized that teachers of secondary mathematics as well as all other teachers should possess a very broad acquaintance with the affairs of the world about them and that they should bring a professional point of view to their work, these features of their training should be similar to or comparable with those of teachers of other academic subjects. This point will not be discussed here. The mathematical training of a teacher of this subject in the secondary schools should be determined by the curriculum content of these schools, the future needs and trends in this field, the facilities of the teacher-preparation institutions, and the availability of candidates for the teaching profession. Because the junior and senior high school curricula differ, separate courses for junior high school teacher-preparation should be set up that will adequately prepare teachers for this work. If junior high school teaching continues more and more to be departmentalized, the training of teachers for this level of instruction should recognize departmentalization, and certificates should be issued along these lines. The specific subject matter or academic training backgrounds of junior high school teachers probably should differ little from that of other secondary teachers of the same subject. The point of view should perhaps be different. Because the junior high school, as a unit of school organization, has not yet

[18]Evenden, E. S. op. cit., p. 111.

reached the stages of maturity, the suggestions and recommendations for specific mathematical training of teachers will be given in terms of the needs of secondary mathematics teachers with emphasis upon the more prevalent four-year high school unit.

For more than a century, the trend has been to incorporate mathematical materials that formerly were considered of collegiate rank into the secondary school curriculum. This has been done with *arithmetic, algebra, geometry, trigonometry,* and is now being done with *differential calculus.* This trend makes it imperative that teachers in this field have a much more extensive acquaintance with the field of mathematics than was necessary formerly. Furthermore, in order to illuminate his teaching, to really understand the scope and significance of the various topics to be taught on the secondary level, it is necessary for a teacher to possess a mathematical acquaintance considerably beyond that which it is hoped the pupils will acquire. For instance in the topic of graphs, which is now taught in both elementary school *arithmetic* and in high school *algebra,* there is a relation between the simple statistical graph and the graph of a function. To really understand and appreciate the significance and the use of a graph as an illustrative device or as a mathematical concept, a teacher should possess some knowledge of *arithmetic,* of *algebra,* of *analytic geometry,* of *trigonometry,* of *differential* and of *integral calculus* as well as the *methods of statistical organization and analysis.* Teachers who have studied these branches of mathematics recognize this at once; those who have not demonstrate that appreciation and understanding depend upon knowledge. This difference is illustrated by the discrepancy between the understanding and use of the concept of the normal curve of probability by one who has only a superficial acquaintance with its shape and the area under it gained through counting squares on cross section paper, and one who understands how the technique of integration may be applied to an equation representing this curve.

The matter of the selection of students for teacher-training institutions has received much attention in late years but has not yet reached the point where prospective teachers can be selected with a high degree of assurance that they will become successful teachers. The problems in selecting students who will become good teachers of secondary mathematics are probably

similar to those encountered in selecting students for teacher-training in other academic fields. From an analysis of several studies that have been made in the field of prospective-teacher selection, we may conclude that at least three things are desirable. These are: sufficient intelligence to complete prescribed courses; a positive teaching personality (whatever that is); and a desire to teach. Many institutions are now experimenting with various methods of teacher selection. These experiments may lead to more reliable means of selecting those who possess the potential teaching qualifications.

The mathematical study that will provide a teacher of secondary mathematics with an adequate background for understanding and teaching this subject can be acquired in the four year college course which is now commonly required for entrance to high school teaching. However, it is necessary that this course be well arranged and that the prospective teacher determine upon teaching as a profession early enough so that the majority of the material may be learned from a teacher's point of view. A program of mathematics courses has been planned which will give a sufficient background for teaching secondary mathematics and which will also permit the student to study sufficiently in other fields so that he may be acutely aware of the civilization in which he lives. These courses follow the general academic pattern of existing schools and the credit assignments are both desirable and near current practice.

The following courses are recommended on the basis of inferences drawn from the data of this study.

COLLEGE MAJOR IN MATHEMATICS

Academic Courses	Credit in semester hours	
	minimum	desirable
Mathematical analysis or general mathematics (1st yr.)	6	6
Analytic geometry	3	6
College geometry	3	3
Modern geometry	3	6
Calculus	6	8
Fundamental concepts of mathematics	3	5
Applied and Related Courses		
History of mathematics	2	3
Statistical method	3	6
Mathematics in modern life	3	3
Total Mathematics Courses	32	46

COLLEGE MINOR IN MATHEMATICS

Academic and Related Courses	Minimum credit in semester hours
Mathematical analysis or general mathematics (1st yr.)	6
Analytic geometry	3
Calculus	6
Elective, with college geometry or statistical method recommended	3
Total Mathematics Courses	18

THEORETICAL AND APPLIED COURSES IN "EDUCATION"

Courses in Education	Credit suggested for Mathematics majors	Mathematics minors
Introduction to educational concepts	3	3*
The teaching of mathematics (professional treatment of materials)	6	3
Observation and practice-teaching	3	2
Psychology, measurements, and other courses in educational theory	9	9*
Total Credit in Education for Majors	21	
Additional Education in Minors		5

The content of most of the recommended courses has already been well established by practice. However, it would be highly desirable for the teachers of these courses to have sufficient professional interest so that they would link the materials in the college courses to work of the secondary school. The *general mathematics* course that has been suggested for college freshmen should be thoroughly mathematical and at the same time give a more comprehensive view of the field of college mathematics than is possible under the more narrow limits of individual courses which are usually taught in the first year of college. The course, *fundamental concepts of mathematics*, is now being taught in the senior year in some colleges and in graduate years in others. This course should come late in the student's training period and should form an integrating study for the more specialized courses he has

*Same course for any majors and minors, no duplicate credit.

previously studied. In the group of related courses which are fundamentally mathematical, a new course has been recommended, i. e., *mathematics in modern life.* This should acquaint the prospective teacher with actual and potential uses of mathematics in such divers fields as the physical and natural sciences, astronomy, geodesy, finance, industry, the fine arts, aesthetics, and philosophy. While it is admitted that such a comprehensive course has not yet been organized, there is a great need for it. This course should at least open the doorway to diverse fields of analysis and should point the direction and scope of mathematical thinking in these fields so that a prospective teacher not only gains an appreciation of the fields themselves, but also sees the nature of additional study necessary for a further exploration and investigation. This mathematical background has been planned so that teachers of the subject in secondary schools may teach mathematics more intelligently, and also so that vistas of independent research may be opened to them, vistas that have hitherto been denied because of the meagerness of the training of many teachers and the lack of coordination of the courses studied.

A minimum total of thirty-two semester hours of work in academic and related mathematics courses has been recommended. While this is slightly more than the typical college major in mathematics, it is by no means excessive, and can easily be included in the usual college course of four years in which the total amount of study is 120 semester hours. The suggested amount of study is forty-six semester hours, which is probably more than can be included in a four year curriculum. This should form a goal for future training programs in which the training period for high school teachers is raised from four to five years of collegiate preparation. This recommendation presupposes the completion of at least three units of credit in mathematics in a regular high school. In addition to the minimum courses recommended in the major, there should be several advanced courses offered for election by students who wish to further specialize. Many of the colleges that offer majors in mathematics offer much more work in the field than has been here suggested, and some of the teachers colleges are now requiring more than the minimum recommended in this report.

Because overspecialization in itself is not desirable for secondary teachers of any subject and also because it will continue to be

necessary for a minority of teachers to give instruction in more than one field, teachers should be adequately prepared to teach in at least two related fields. There are many teachers who feel that it is desirable to instruct in two fields such as physical science and mathematics. Whether preparation should be made in more than one major field or in one major and one or more minor fields is a debatable issue. Because of the number of other required courses in colleges and because of the diversity of curricula in small high schools, it would probably be better for students to prepare in one major and in one or more minor fields. While the preparation in a minor field cannot be as extensive as in the major field, it should include a minimum academic background and some professional preparation such as special methods and practice-teaching in the minor field.

A minimum total of eighteen semester hours of work in mathematics has been recommended for teachers who wish to select this field as one of minor interest. While this amount of study is not very large, it will insure a preparation which is better than that possessed by a large group of current teachers of mathematics. If a student completes a major of thirty-two semester hours, a minor of eighteen semester hours, and the suggested total of twenty-six semester hours of work in the field of education, he still has forty-four semester hours to devote to other required and elective courses.

The preceding recommendations have been made primarily for senior high school teaching. For junior high school teaching the problem is somewhat different in that approximately one-third of all the classes taught by teachers who teach mathematics in junior high schools (Table 38) are not classes in mathematics. Unless junior high school teaching becomes more departmentalized, teachers in this type of school will continue to need training in several teaching fields. They therefore cannot attain the same degree of specialization that has been suggested for senior high school teachers. For junior high school teaching in these units as now organized, the minumum training in mathematics should be the completion of the academic minor together with observation, practice-teaching, and a professional course in the materials and methods of junior high school mathematics.

While courses in educational theory may not assure a professional attitude on the part of the teacher in training they offer

an opportunity to enrich and to extend the professional atmosphere within an institution as well as to contribute principles of teaching and learning that are definitely useful in teaching. Many of these principles are applicable to most fields of teaching but they require more specific application to various subjects to be most useful. Not only should principles of teaching and learning be studied; they should also be applied by the student in apprentice or practice-teaching. Twenty-one semester hours of work in general educational theory and in education applied to the teaching of mathematics have been suggested for students majoring in mathematics, and five semester hours specifically related to mathematics teaching have been suggested for students who are primarily interested in teaching some other subject as a major interest and mathematics as a minor interest. If this apportionment of credit holds for majors and minors in all departments, then a student who pursues one major and one minor would have a total of twenty-six semester hours—twelve of which are general educational theory and fourteen of which are definitely related to his major and minor teaching fields. Again it is desirable to point out that the mechanical details of arrangement and amount of credit are of secondary import in relation to the way in which these courses or phases of work are carried on. There is some evidence to believe that the prevalent practice of placing most or all of the work in observation and participation in teaching near the end of the course is not desirable; that instead, the student in training should start this work nearer the beginning of his training period and gradually participate more fully in the actual teaching of a class under typical school conditions. The testimony of teachers now in the field suggests that the planning and supervision of the participation of a student-teacher should be done by one who knows both educational theory and academic mathematics and has had or is doing some teaching on the secondary level.

CERTIFICATION OF TEACHERS

It is recommended that certification be made the primary means of insuring adequately prepared teachers of mathematics for the secondary schools. The present practices in certification have not insured a satisfactorily trained personnel in this field. Likewise school administrators and other school officials who have

been employing teachers locally, have not engaged teachers of mathematics with high levels of training in their teaching field. Furthermore, the teachers who have been in service for a long period of years have not been stimulated to advance their training in keeping with the general advances of education. Finally, the training agencies are largely non-professionalized and prospective teachers may enter the ranks of secondary mathematics teaching with a nominal professional background which was presented by a department of education unrelated to the department of mathematics, and often ridiculed by the professors of mathematics. Under this arrangement, professional integrity could not be secured within the agencies that have actually been preparing teachers. Because the public schools including the public high schools have been established under the jurisdiction of the separate commonwealths, these commonwealths not only have the right but it is their obligation to establish the standards for schools within their jurisdiction. This is accomplished by the legal expedient of certifying teachers and accrediting schools. The latter can be made dependent upon the former as one of the criteria for accreditment, hence the former will be considered here.

There are two aspects to this problem of certification; first, the certification of new teachers for the schools; second, the raising of the qualifications of present teachers to a desired level. The qualifications of new teachers can be advanced readily in times of teacher over-supply. If that part of the current teaching population that is not adequately prepared for teaching secondary mathematics could be eliminated there probably would be no over-supply of teachers. If new teachers could be assured employment after having adequately prepared themselves, it is probably true that many present unemployed teachers would make sufficient sacrifices to gain an adequate level of preparation such as that recommended in the previous section of this chapter.

One method of raising the qualifications of the present teachers of secondary mathematics could be accomplished through first educating the principals and superintendents of schools to a point where they are able to recognize both successful and intelligent teaching of mathematics. This method is indirect and it is probably weak in that even though the school executives possessed these qualities of discernment, there is no assurance that they could be free to act according to their best judgment. Again

we are faced with the inadequacy of our present measures of teacher success. Another means of elevating the qualifications of those teachers who are improperly or insufficiently prepared is through the accrediting of secondary schools by the various state departments of education. An example of the progressive raising of standards for teachers in accredited high schools has already been described in the chapter on certification. This method could be more widely employed than it is at the present time and should be especially effective in states where teachers hold permanent certificates that were issued on comparatively low levels of training.

Permanent certificates should not be issued to new teachers in the future. Through a system of temporary certificates, which are periodically reissued upon evidence of successful teaching and a higher level of training, the qualifications of teaching groups could be gradually advanced. In a recent study of this problem, Stine arrived at the following conclusions: "Teaching methods and techniques are constantly changing, and teachers must keep abreast of the times. Institutionalized training is not sufficient. College graduates should be required to continue their education during a period of service, and a means of study and additional professional growth should be provided."[19] And again, "The facts presented are convincing evidence that stringent regulations requiring more inservice education for renewable and exchangeable certificates are desirable."[20] While Stine made a special study of this problem it is regrettable that he merely pointed out a need which several states have already partially met and did not show how states in general could wisely define the problem and solve it, or the nature of further study involved in seeking a solution. The problems involved in the issuance of temporary certificates are probably more similar among the different states than they are dissimilar. A federal agency such as the United States Office of Education could do much in bringing this problem before the nation as a whole and ought to be in a position to make definite suggestions.

Because the mere completion of a four year college course that includes a minimum prescribed amount of study in the field of educational theory is no assurance that the college graduate is

[19]Stine, Mark E. State Certification as a Potential Influence on the Education of Teachers in Service. Unpublished doctor's thesis, 1932. New York University, New York. p. 186.

[20]Stine, op. cit., p. 188.

qualified to teach mathematics, and because school officials frequently employ teachers in fields for which they have had no special training, certification regulations should be extended so that teachers of academic subjects in the secondary schools are legally qualified to teach only those subjects or fields in which they have college majors or minors such as have been described and recommended for teachers of mathematics. Such a move could be hastened if teachers of academic subjects would send recommendations jointly and severally to the certifying authorities in the different states. The teachers of mathematics through their state, national, and sectional organizations probably have more influence than has hitherto been realized.

An element of the education of teachers of secondary mathematics, which for some is undoubtedly very significant, has not been included in this study. This is the knowledge gained through experience and personal study. It was recognized at the time this study was undertaken that such individual study might be very significant to a minority of teachers. However, the members of the American Committee felt that it would be impossible to measure the amount and the benefits derived from such study for a large group of teachers. This would be an interesting and valuable investigation in itself.

APPENDIX

The appendix contains the following forms:

FORM A— The original questionnaire composed by Professors Klein, Loria, and Fehr for the International Commission on the Teaching of Mathematics

FORM B— The inquiry form used by the National Survey of the Education of Teachers

FORM C— The auxiliary inquiry form of the American Committee and the National Survey of the Education of Teachers

FORM D— The form used in this study to gather information about certain questions pertaining to the certification of teachers

FORMS E AND E'— Forms used in this study to learn about the training programs of a limited group of teacher-training institutions

FORM A

INQUIRY INTO THE TRAINING OF TEACHERS OF MATHEMATICS IN SECONDARY SCHOOLS IN DIFFERENT COUNTRIES

I.—GENERAL-PREPARATION OF CANDIDATES

a) How are teachers of mathematics for secondary education trained in your country?

Are there special institutions devoted to this task, or departments organized for this purpose in university or technical institutions for higher education?

If there is no special organization or regulation laying down a definite qualification to be obtained, what is the ordinary course of training pursued by teachers in your secondary schools?

Are there special conditions for girls' schools?

b) What are the courses of study followed by future teachers? public schools, high schools, etc., giving secondary education, classical or scientific? Is a knowledge of Latin required of future teachers of scientific subjects?

Besides the theoretical preparation, are any practical attainments of a professional kind required?

c) Are there regulations or traditions demanding a knowledge of other subjects besides pure mathematics from such candidates? If so, are these subjects applied mathematics, mechanics, physics or branches of natural science; or on the other hand, topics of general culture such as philosophy, foreign languages, history, etc.?

d) Is the scientific training separated from the purely professional?

e) In many countries special scholarships exist for persons intending to enter the teaching profession. We desire to know the state of matters as regards this.

II.—THEORETICAL SCIENTIFIC TEACHING

1.—What is the theoretical preparation? What modes of teaching are used? (lectures, discussions, exercises, preparation, practical work, etc.) Time required? Which methods are obligatory and which optional?

The following classification is suggested:

a) pure mathematics,

b) applied mathematics, including rational mechanics and mathematical physics,

c) elementary mathematics considered in reference to principles,
the foundations of mathematics,
history of mathematics.

(Information is particularly sought as to the extent and nature of courses on the history of mathematics, and on the text-books used, if any.)

d) Other branches of science. Optional or compulsory.

2.—Is the theoretical preparation tested by an examination for a degree or a Government examination? How are these examinations organized?

III.—Professional Training

1.—Professional training may include:

a) Study of method (didactic mathematics),

b) Study of pedagogic method in the wide sense,

c) Practical initation into the usual methods, of applied mathematics,

d) Study of educational legislation,

e) Practical preparation, actual work in schools.

To what extent do these different objects receive attention? What time is devoted to them?

Is this preparation partially obtained at the University or during a probationary stage at a school?

Detailed information upon the following points would be welcome:

a) Method. Do candidates receive at the University any instruction in the methods of mathematical teaching? Syllabus?

Are the lessons given by a University professor or by a teacher in a school?

b) Pedagogy. Do the candidates undergo courses in pedagogy or psychology? What is the current opinion in your country as to the value of these courses?

If it is unfavorable, is the opposition based upon the spirit in which the instruction is given, or is it simply thought that the time occupied might be better employed?

c) Would the creation of a course in pedagogy based on the experimental ideas and specially destined for future teachers of science be viewed with favor?

Is the development of practical skill encouraged (measurements, calculation, drawing, actual surveying or workshop

practice) so as to familiarize such persons with the commonest applications of elementary mathematics?

d) EDUCATIONAL LEGISLATION. Do candidates follow a course on this subject? Syllabus?

Does it include all the educational institutions of your country? Is it limited to the law of your own country, or does it include a study in comparative legislation?

Does it make use of the publications of the International Commission?

e) PRACTICAL TRAINING. (probationary work in school, etc.) What practical training do candidates receive in your country?

Does this training commence (while theoretical studies are still continuing) by means of lessons given in a school by the candidate in the presence and under the direction of a professor, or does it form a stage by itself immediately after the university course?

If the latter, please indicate the organization of this stage, the conditions the government establishes, and how they are received by the authorities in the secondary schools.

2.—Is the professional training tested by an examination, or by a series of lessons given by the candidate? How are the examinations organized?

IV.—SUBSEQUENT IMPROVEMENT

a) Are teachers in secondary schools expected to attend vacation courses or lectures so as to keep in touch with the progress of science and scientific teaching?

Or can they for this purpose obtain one or two terms' leave, after a certain number of years spent in teaching?

b) Details should be given here of the part played by scientific or pedagogic societies.

c) The activity of a professor may be estimated in reference to his employment in actual teaching, or to his personal scientific researches.

What view is taken in your country as to this?

d) Do teachers in secondary schools advance to university or higher educational posts?

What conditions have to be fulfilled in this respect?

Mention any mathematicians of position who have passed from posts in secondary education to posts in higher education.

V.—Legal Provisions as to Teachers

a) What are the qualifications of teachers in the secondary schools, and how are they recruited?

Is the degree of Doctor demanded?

Are women included in the above regulations?

b) With what branches of instruction may a teacher of mathematics be charged?

Is the teaching of mechanics entrusted to the department of physics or of mathematics?

Is the teaching of descriptive geometry entrusted to the department of mathematics or of drawing?

c) Information as to number of hours of teaching, average salary, prospects of promotion, and pension, will be gladly received.

d) Are the teachers of mathematics expected to join in conferences with members of the other scientific departments of the institutions to which they belong?

Are they required to assist in the formulation of programmes of study?

If not, by whom and how are the courses of study settled?

VI.—Bibliography

Are there in your country books especially devoted to the training of teachers of science, or of mathematics in particular? Have you journals dealing specially with scientific education?

VII.—Additions

If you consider that you can add usefully any observations on questions not dealt with above, you are requested to do so.

Replies should be addressed to Professor Gina Loria, 41, Piazza Manin, Genoa, Italy.

Kindly write on one side of the page only.

UNITED STATES DEPARTMENT OF THE INTERIOR

OFFICE OF EDUCATION

WASHINGTON

January 12, 1931.

TO TEACHERS, SUPERVISORS, AND ADMINISTRATORS:

The present unemployment of many experienced and trained teachers led the Seventy-first Congress, at the request of professional organizations, to provide for a nation-wide survey of the demand for and education of teachers, supervisors, administrators and other specialists in the public school systems of the United States. You may have answered similar questions for local studies. However, to secure data comparable between States, all teachers and other professional employees are asked to reply to the same set of questions.

This study is solely for the improvement of American education. Since the questions are few in number and easily answered, please respond promptly. Mail answers in the official envelope which requires no stamp. Your answers are confidential. They will be used for group studies only.

Cordially yours,

Wm. John Cooper

Commissioner of Education.

(Your name)	(Your post office address)	(State)

THE NATIONAL SURVEY OF THE EDUCATION OF TEACHERS

Read carefully. DIRECTIONS: In the columns below are two types of questions. One type is answered by inserting the information requested in the space provided at the left of the question. The other type is answered by encircling the *one* code number to the left of the item which best represents your response to the question asked; e. g., in 9, YOUR WORK IS DONE IN ② Elementary School.

Use a red or soft pencil preferably. Draw the circle neatly around the *one code number* representing your response. Please answer every question which pertains to your type of service.

9

YOUR WORK IS DONE IN:

0 Nursery School.
1 Kindergarten.
2 Elementary School.*
3 Junior High School.†
4 Senior High School.⊙
5 Junior College.
6 Evening School.
7 City system as a whole.
8 County or County Institution.
9 State Office or State Institution.

*Elementary grades 1, 2, 3, 4, 5, and 6, and, where separate junior high schools are not maintained, grades 7 and 8 also.

†Junior high school grades 7 and 8, or 7, 8, and 9 when maintained as a separate school organization.

⊙Senior high school grades 10, 11, and 12 where junior high school is maintained; otherwise grades 9, 10, 11, and 12.

10-11

BEST DESCRIPTION OF YOUR MAIN WORK:

00 Teacher of Grades or Academic Subjects.
01 Continuation School Teacher.
02 Visiting Teacher.
Teacher of Special Subjects—
03 Agriculture.
04 Art and Drawing.
05 Commercial.
06 Health, Physical Education.
07 Home Economics, Household Arts.
08 Industrial Arts.
09 Music.
10 Naturalization, Adult Illiterates, Americanization
11 Trades and Industries.
12 Vocational, Technical.
Teacher of Special Classes—
13 Blind.
14 Crippled.
15 Cardiac, Nutrition, Open Air, etc.
16 Deaf.
17 Speech Defectives.
18 Mentally Gifted.
19 Mentally Defective.
20 Disciplinary or temperamentally unbalanced.
21 Other _____ (Give type)
Supervisor—
22 General.
23 Art and Drawing.
24 Exceptional Children.
25 Home Economics, etc.
26 Commercial Subjects.

10-11—Continued

Supervisor—Continued
27 Industrial Arts.
28 Health, Physical Education.
29 Music.
30 Trades and Industries.
31 Principal.
32 Principal, Mentally Handicapped School.
33 Principal, Physically Handicapped School.
34 Assistant Principal.
35 Dean of Boys.
36 Dean of Girls.
37 Superintendent.
38 Assistant Superintendent.
39 Business Manager,
40 Building and Grounds Superintendent.
41 Attendance Officer.
42 Librarian.
43 Cafeteria Manager.
44 Dietitian.
45 School Physician.
46 School Dentist.
47 School Nurse.
48 Coach (athletic).
49 Psychologist.
50 Vocational Guidance.
51 Research or Survey.
52 Teacher Clerk.
53 Other _____ (Give title)

12

NUMBER OF TEACHERS OF TYPE YOU CHECKED IN NO. 9 IN BUILDING IN WHICH YOU TEACH. COUNT YOURSELF AS ONE.

0 One.
1 Two.
2 Three or four.
3 Five to nine.
4 Ten to twenty-four.
5 Twenty-five to ninety-nine.
6 One hundred to four hundred ninety-nine.
7 Five hundred and over.

13

SEX AND MARITAL STATUS:

0 Woman, Single.
1 Woman, Married.
2 Woman, Divorced.
3 Widow.
4 Man, Single.
5 Man, Married.
6 Man, Divorced.
7 Widower.

14

SCHOOL LOCATED IN:

0 Open Country.
1 Village less than 2,500.
2 City, 2,500 to 9,999 population.
3 City, 10,000 to 99,999 population.
4 City, over 100,000 population.

15-16

— — YOUR AGE AT NEAREST BIRTHDAY.

17-18

— — TOTAL NUMBER OF YEARS' EXPERIENCE.
Count school year 1930-31 as one.

19-20

— — Counting present system as one, HOW MANY DIFFERENT SCHOOL SYSTEMS HAVE EMPLOYED YOU?

QUESTIONS 21 AND 22 ONLY FOR THOSE NOW TEACHING ELEMENTARY SCHOOL PUPILS.

21

GRADES NOW TAUGHT ARE:

0 One or Two Teacher Rural Schools
1 Kindergarten, Kindergarten-Primary
2 Intermediate.
3 Upper Elementary.

22

FIELD FOR WHICH YOU TOOK MOST TRAINING:

0 Rural School.
1 Kindergarten-Primary.
2 Intermediate.
3 Upper Elementary.
4 Junior High.
5 Senior High.
6 Junior College.
7 Other _____ (Give name of field)

23-24

YOUR SALARY

$———.00 For school year 1930-31 paid by school boards. To include any additional compensation such as free house, etc. Estimate this.

25

NO. OF MONTHS FOR WHICH YOU ARE EMPLOYED FOR ABOVE SALARY

0 One to six months, inclusive.
1 Seven months.
2 Eight months.
3 Nine months.
4 Ten months.
5 Eleven months.
6 Twelve months.

(OVER)

26

RACE:

0 White.
1 Negro.
2 Indian.
3 Other.

27–28

HIGHEST LEVEL OF TRAINING

00 Nongraduate of elementary school.
01 Graduate of elementary school only.
02 One year of high school.
03 Two years of high school.
04 Three years of high school.
05 Four years of high school.
06 Six to twelve weeks of college.
07 Half year of college.
08 One year of college.
09 Two years of college.
10 Three years of college.
11 Four years of college.
12 One year of graduate work.
13 Two years of graduate work.
14 Three years of graduate work.
15 More than three years of graduate work.

29

____ NUMBER OF YEARS A STUDENT IN JUNIOR COLLEGE.

30

____ NUMBER OF YEARS A STUDENT IN TEACHER'S COLLEGE OR NORMAL SCHOOL.

31

____ NUMBER OF YEARS A STUDENT IN OTHER COLLEGES OR UNIVERSITIES.

32

SOURCE OF EARNED BACHELOR'S DEGREE
(In case of two similar degrees, select the source where you had the most residential work.)

0 State or City Teacher's College.
1 Private Teacher's College
2 State College for Women.
3 City College or University.
4 State University or Land Grant College.
5 Other State-supported College.
6 Private College or University.

INSTITUTION AND DATE—BACHELOR'S DEGREE

33

SOURCE OF EARNED MASTER'S DEGREE

0 State or City Teacher's College.
1 Private Teacher's College.
2 State College for Women.
3 City College or University.
4 State University or Land Grant College.
5 Other State-supported College.
6 Private College or University.

INSTITUTION AND DATE—MASTER'S DEGREE

34

SOURCE OF EARNED DOCTOR'S DEGREE

0 Private Teachers College.
1 City College or University.
2 State University or Land Grant College.
3 Private College or University.

INSTITUTION AND DATE—DOCTOR'S DEGREE

NOTE: In questions 35, 36, 42-43, and 46-47, state credit in terms of semester hours. A semester hour is defined as the equivalent of one recitation per week for a semester (18 weeks). If your credits are in term or quarter hours, transpose them to semester hours by multiplying by ⅔.

35

SEMESTER HOURS OF UNDERGRADUATE AND GRADUATE CREDIT IN "EDUCATION"
(Defined as educational psychology, methods, practice teaching, etc.)

0 No credit in education.
1 1–6 semester hours.
2 7–12 semester hours.
3 13–18 semester hours.
4 19–24 semester hours.
5 25–30 semester hours.
6 31–40 semester hours.
7 41–50 semester hours.
8 51–60 semester hours.
9 Over 60 semester hours.

Is this answer from an exact record? Yes_____No_____

36

SEMESTER HOURS OF UNDERGRADUATE AND GRADUATE CREDIT IN PRACTICE TEACHING (included in 35)

0 No practice teaching credit.
1 1–3 semester hours.
2 4–6 semester hours.
3 7–12 semester hours.
4 13–18 semester hours.
5 Over 18 semester hours.

37

ANSWER THIS IF YOU WERE NOT EMPLOYED IN THE PRESENT SCHOOL SYSTEM LAST YEAR (1929–30.)

The one reason that explained the *demand* for your services this school year 1930–31.

0 Predecessor died.
1 Predecessor retired.
2 Predecessor entered college.
3 Predecessor married.
4 Predecessor left to teach somewhere else in the State.
5 Predecessor left to teach in another State.
6 Predecessor entered another profession or occupation.
7 Predecessor left on leave of absence, illness, etc.
8 Hold newly created position.
9 Other_____

38

ANSWER THIS IF YOU WERE NOT EMPLOYED IN PRESENT SCHOOL SYSTEM LAST YEAR (1929–30.)

Where were you last year?

0 College or university in same State.
1 Teacher training class, normal school or teacher's college in same State.
2 Another school system in same State.
3 College or university in another State.
4 Teacher training class, normal school or teacher's college in another State.
5 Another school system in another State.
6 A position other than in educational work.
7 Leave of absence.
8 Return to teaching, having some occupation other than education the past year.
9 Other_____

THE REMAINING QUESTIONS, 39 TO 48 INCLUSIVE ARE ONLY FOR THOSE WHO TEACH OR SUPERVISE JUNIOR HIGH SCHOOL, SENIOR HIGH, AND JUNIOR COLLEGE CLASSES

39

____ NUMBER OF DIFFERENT FIELDS, AS LISTED IN 40-41, IN WHICH YOU NOW GIVE INSTRUCTION.

40–41

THE FIELD WHICH YOU TEACH PRINCIPALLY

00 Agriculture and Forestry.
01 Art and Drawing.
02 Biological Sciences.
03 Business and Commerce.
04 Education and Teacher Training.
05 English.
06 Classic Languages.
07 Modern Languages.
08 Health and Physical Education.
09 Home Economics or Household Arts.
10 Physical Sciences.
11 Mathematics.
12 Music.
13 History, Sociology, Economics.
14 Trades and Industries and Industrial Arts.
15 Subject not listed here:

_____ (write name of field)

42–43

__ __ NUMBER OF SEMESTER HOURS GRADUATE AND UNDERGRADUATE CREDIT EARNED IN FIELD CHECKED ABOVE.

44–45

YOUR NEXT MAIN FIELD OF TEACHING

00 Agriculture and Forestry.
01 Art and Drawing.
02 Biological Sciences.
03 Business and Commerce.
04 Education and Teacher Training.
05 English.
06 Classic Languages.
07 Modern Languages.
08 Health and Physical Education.
09 Home Economics or Household Arts.
10 Physical Sciences.
11 Mathematics.
12 Music.
13 History, Sociology, Economics.
14 Trades and Industries and Industrial Arts.
15 Subject not listed here:

_____ (write name of field)

46–47

__ __ NUMBER OF SEMESTER HOURS GRADUATE AND UNDERGRADUATE CREDIT EARNED IN FIELD CHECKED ABOVE.

48

YOUR TEACHING LOAD, CLOCK HOURS PER WEEK.

0 1–9 clock hours.
1 10–14 clock hours.
2 15–19 clock hours.
3 20–24 clock hours.
4 25–29 clock hours.
5 30–34 clock hours.
6 Over 35 clock hours.
7 I do not teach.

NOTE: Teachers in Junior High or Senior High Schools or Junior Colleges having transcripts or exact records of college courses, list by titles and give credit in semester hours for the undergraduate and graduate Courses taken in your major and minor teaching fields (as checked in 40-41 and 44-45).

Example: Teacher with major teaching field in English may list: Freshman Composition 3 sem. hrs.; American Literature 4 sem. hrs., etc.

UNDERGRADUATE COLLEGE WORK				GRADUATE COLLEGE WORK			
Major Teaching Field		Minor Teaching Field		Major Teaching Field		Minor Teaching Field	
Title	Sem. hrs.	Title	Sem. hrs.	Title	Sem. hrs.	Title	Sem. hrs.

U. S. GOVERNMENT PRINTING OFFICE: 1931

FORM B

FORM C

CONCERNING YOUR EXPERIENCE:

On the blanks below give your present teaching load, including all subjects. Put mathematics courses first.

SUBJECT	No. OF CLASSES	CLASS PERIODS IN MINUTES	GRADE	No. OF PUPILS
(Sample) — algebra	2	45	9	63

Occupation and experience: Give the number of years in the blanks provided.

.....in non-teaching work since H. S. graduation
.....as an elementary teacher
.....as a Jr. H. S. teacher
.....as a Sr. H. S. teacher
.....as a college teacher
.....total years of teaching

.....training beyond El. school before doing any teaching
.....training beyond El. school before present position
.....No. of points or Sem. Hrs. credit earned while in present position

What earned degrees do you hold?.....

List below the normal schools and colleges attended:

.....

.....

For all items that follow use this key by inserting the letter in the blank. Key: A = very important, B = valuable, C = a little value, D = no real value.

Effectiveness of your training in the light of your experience. Rate the following items according to their helpfulness to you as a teacher.

.....courses in academic college Math.
.....courses in professional Math.
.....courses in educational theory
.....courses in Obs. and Pract. Teach.

.....an understanding of boys and girls
.....a natural inclination to teaching
.....advice of colleagues and school officers
.....my own hard work on the job

Will you please give a brief statement telling what you consider has been the chief contributing factor to your success as a teacher.

.....

.....

.....

What influenced you most in becoming a teacher of mathematics?

.....influence of a high school teacher
.....influence of a college teacher
.....I liked the subject and wished to teach it

.....by pure chance or accident
.....requested or required to teach Math.
.....

Reasons why you did not study more academic mathematics?

.....I took all that was offered
.....I took as much as was required
.....I didn't like the teachers of Math.

.....I never expected to teach mathematics
.....I didn't like mathematics
.....

Some main reasons for teaching algebra and geometry:

1. Elementary algebra (usually 9th grade)

.....trains pupils to think abstractly with symbols
.....it is necessary for a further study of mathematics
.....it is directly useful in the life about us

2. Plane geometry (usually 10th grade)

.....it trains pupils to think logically in life situations
.....it acquaints pupils with geometric figures that are found in our surroundings
.....it gives pupils valuable practice in deductive thinking
.....it is needed for entrance to most colleges

Professional magazines: List those you read regularly:

MATHEMATICAL	GENERAL

UNITED STATES DEPARTMENT OF THE INTERIOR

OFFICE OF EDUCATION

WASHINGTON

April 5, 1932.

To Junior High School and Senior High School Teachers of Mathematics:

A more intensive study of the status of secondary mathematics teachers in the United States is being made by the American Committee of the International Commission on the Teaching of Mathematics in cooperation with the National Survey of the Education of Teachers.

This inquiry sheet contains some definite items which individual teachers of mathematics should answer so that we may have an accurate and adequate picture of this group in our country. All responses will be treated confidentially and will be used only in large impersonal group studies. Your name may be omitted. Replies should be sent as a group from each school in the penalty envelope provided.

Cordially yours,

The American Committee

E. R. Hedrick
B. W. Frazier
W. D. Reeve
B. A. Sueltz
Eva May Luse

Commissioner of Education

Note: This blank should be filled by *all teachers* who are teaching *one or more classes in mathematics* in a Jr. H. S. or a Sr. H. S. (Jr. H. S. means grades 7, 8, 9 or grades 7 and 8 where a separate organization is maintained. Sr. H. S. means grades 9, 10, 11, 12 or grades 10, 11, 12.)

State	City	Your Name	Jr. H.S. or Sr. H.S.	Main Teaching Field (as Eng., Math., Science)

CONCERNING YOUR TRAINING:

In the blanks at the left of each course below give the number of semester hours credit that you have had in each course. One semester hour means one hour of recitation per week for one semester. (Quarter hours x 2/3 = semester hours.)

Courses in academic mathematics, high school and college:

		Other Courses
.....El. algebra to quadratics	.....plane geometry	.....
.....intermediate Alg. (2nd yr.)	.....solid geometry	.....
.....Adv. Alg. or college Alg.	.....trigonometry	.....
.....general Math. (Fresh. yr.)	.....theory of equations	.....history of mathematics
.....Math. analysis (Fresh. yr.)	.....theory of numbers	.....astronomy
.....Math. analysis (2nd yr.)	.....differential equations	.....mathematical statistics
.....college algebra	.....advanced calculus	.....mathematics of finance
.....trigonometry	.....theory of groups	.....mechanics
.....Pl. analytic geometry	.....vector analysis	.....surveying
.....solid analytic geometry	.....descriptive geometry	.....college physics
.....calculus (Diff. and Integ.)	.....modern geometry (projective, non-Euclidean)	.....

Please underline those courses in the group above that have definitely contributed to your teaching of mathematics.

Courses in professional mathematics for teachers:

.....teaching of Jr. H. S. mathematics	.....the teaching of algebra
.....teaching of Sr. H. S. mathematics	.....the teaching of geometry
.....supervision of mathematics	.....the teaching of arithmetic

Please underline those courses in professional mathematics for teachers that you have found definitely helpful and put a cross (X) after those that were taken before you began teaching mathematics.

Courses in educational theory (psychology, principles of education, etc.):

.....give the total number of semester hours that you have studied educational theory

.....give the number of semester hours credit that you have in observation and practice teaching

List below any courses in educational theory that you have found definitely helpful to you as a teacher of mathematics.

1. .....
2. .....
3. .....
4. .....

FORM D

THE INTERNATIONAL COMMISSION ON THE TEACHING OF MATHEMATICS

THE AMERICAN COMMITTEE

QUESTIONS PERTAINING TO CERTIFICATION

1. Does your state certify (license) junior high school and senior high school teachers separately? .....

2. Are special requirements listed for teachers of mathematics which are not required for teachers of other academic subjects such as English, history, and science?
   a. For junior high school teachers .....
   b. For senior high school teachers .....

3. Are teachers certified on the basis of educational training or examination or both?
   a. For junior high school teachers .....
   b. For senior high school teachers .....

4. What educational level must be attained by teachers of mathematics as shown by the number of years of education and training beyond high school graduation?
   a. For junior high school teachers .....
   b. For senior high school teachers .....

5. What academic subject matter requirement as shown by semester hours of credit in academic college mathematics is set up for certification of teachers of mathematics?
   a. For junior high school teachers .....
   b. For senior high school teachers .....

6. What are your state's requirements in the fields of practice teaching and educational theory?
   a. For junior high school teachers in terms of semester hours:
      1. Practice teaching including observation .....
      2. Educational theory courses or subjects .....
         (if specific courses are prescribed please list them below)
      .....
   b. For senior high school teachers in terms of semester hours:
      1. Practice teaching including observation .....
      2. Educational theory courses or subjects .....
         (if specific courses are prescribed please list them)
      .....

Reply to: B. A. Sueltz
The American Committee
State Normal School
Cortland, New York

FORM E

REPRESENTATIVE TEACHER-PREPARATION INSTITUTIONS

I. Mathematics faculty:
1. How many members of the faculty devote their major time to work in the field of mathematics? .....
2. How many of these faculty members devote their major energy toward courses designed primarily as teacher-preparation courses? .....
3. How many members of the department are actually teaching or supervising work in the secondary field? .....
4. How many faculty members in the department of mathematics have had more than one year of teaching experience in a secondary school? .....

II. School organization:
1. Is the main purpose of the classes in academic mathematics in your school one of educating future teachers?.....
2. What per cent of the undergraduate members of classes in academic mathematics normally become teachers of mathematics? .....
3. How is the student teaching (practice teaching) planned and supervised? (a) by teachers of mathematics, (b) by teachers of educational theory, (c) a separate practice department. ....
4. Is the secondary school in which the student teaching is done maintained as (a) a regular part of your institution, (b) a partially controlled city school, (c) a city school or schools that cooperate with the college. .....
5. Do you in any way limit the number of entering students who plan to become teachers of mathematics? .....
6. On what basis and in what manner are entering students selected?
   (a) by entrance examination? ..... If so, in what fields are the tests given? .....
   (b) by relative standing in high school graduating class .....
   (c) certification of potential teaching worth or ability? .....
   (d) we accept students on the basis of high school graduation. .....
   (e) we make no effort to select those who will be teachers. .....

NOTE: If you feel that you should more adequately describe your program of teacher preparation please do so on a separate sheet. If you have time we would appreciate brief discussions of:
a. general success of your program in preparing teachers of secondary school mathematics.
b. the worthwhileness of student teaching as training.
c. suggestions for a more ideal "set up".

PROGRAM OF COURSES STUDIED BY STUDENTS WHO WILL BECOME TEACHERS OF SECONDARY MATHEMATICS

FORM E-1

	Mathematics*			General and Cultural			Education, Practice Teaching		
	Minimum Required Courses	A Typical Student's Program	Sem. Hrs. Cr.	Minimum Required Courses	A Typical Student's Program	Sem. Hrs. Cr.	Minimum Required Courses	A Typical Student's Program	Sem. Hrs. Cr.
First Year									
Second Year									
Third Year									
Fourth Year									

*Mathematics includes such teaching courses as "The Teaching of Algebra" if these courses are professional subject matter. If the courses are mainly "methods" list them Education.

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3. Selected Topics in the Teaching of Mathematics.
4. Significant Changes and Trends in the Teaching of Mathematics Throughout the World Since 1910.
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VITA

Ben A. Sueltz

Ben A. Sueltz was born on April 20, 1902, at Braddock, North Dakota.

He attended the public elementary and secondary schools of North and South Dakota. In 1922, he was graduated from the Northern Normal and Industrial School at Aberdeen, South Dakota, with the degree of bachelor of science, with a major in mathematics and with minors in English, chemistry, and history. In 1927 he completed the work for the master of arts degree at Teachers College, Columbia University. The summers of 1929 and 1930 were spent in graduate study in Cornell University.

For one and one-half years he served as part-time teacher of mathematics in the Northern Normal and Industrial School at Aberdeen, South Dakota, while completing his work for the first degree. The following three years he was principal of schools at Trail City, South Dakota. Since the completion of his master's degree, he has been in charge of the work in mathematics at the State Normal School at Cortland, New York.

Mr. Sueltz is a member of the national honorary fraternities of Pi Kappa Delta, Kappa Delta Pi, and Phi Delta Kappa. He has served on curriculum and syllabus committees on mathematics in New York State, and is a member of the American Committee of the International Commission on the Teaching of Mathematics.